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Iron and Steel ENGINEER

VOL. XIV MAY • 1937 NO. V

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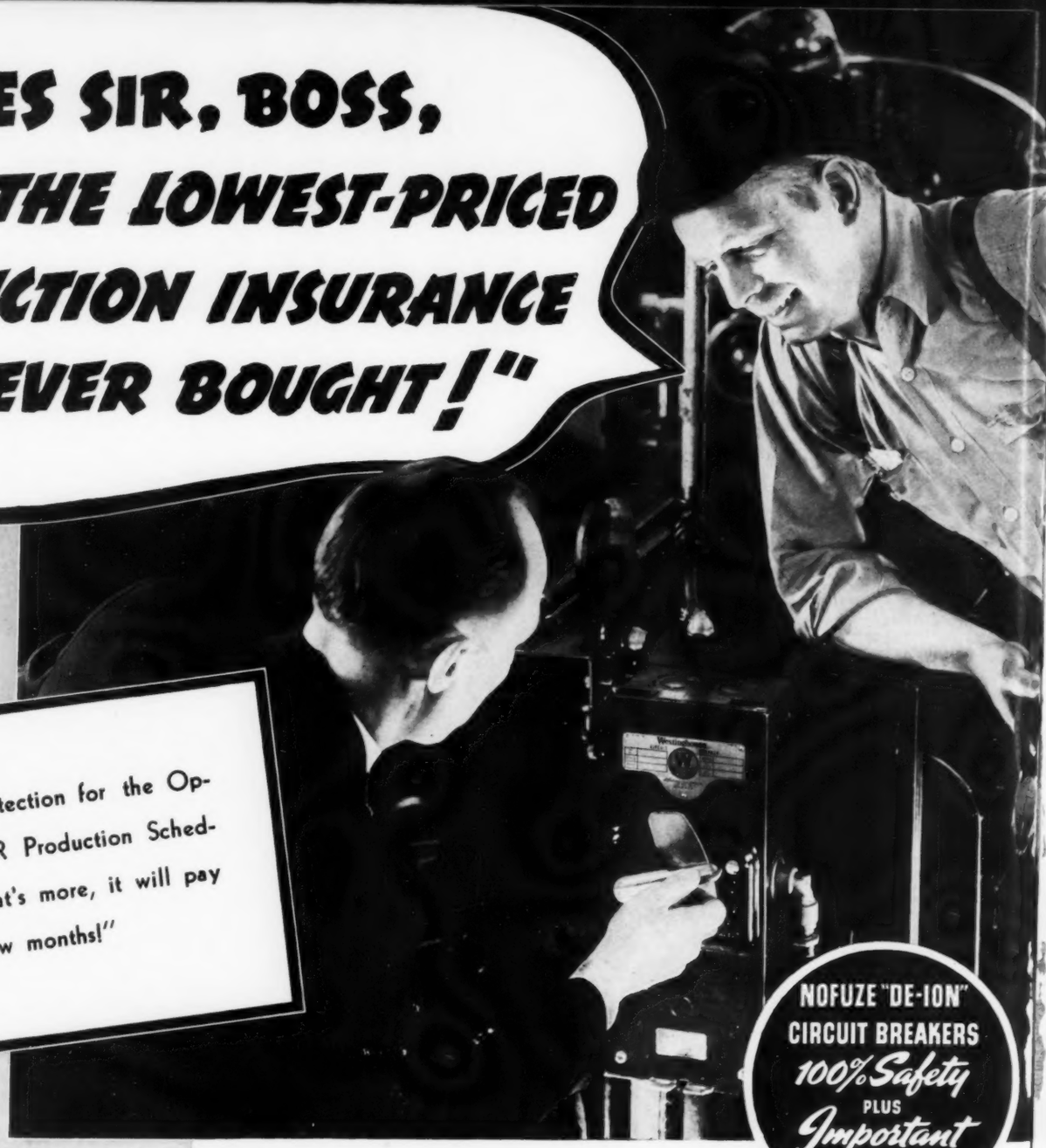

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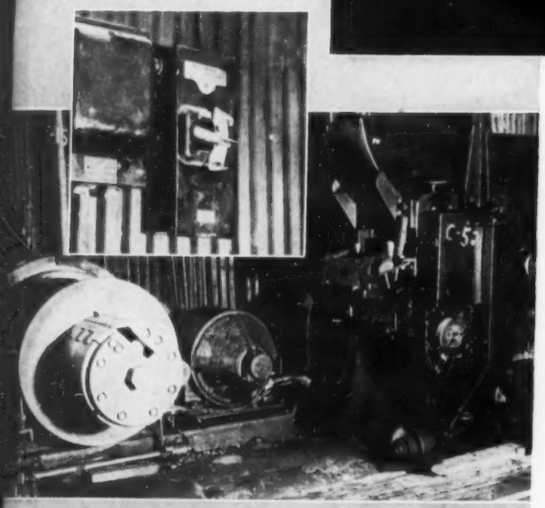

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The Association's Thirtieth Birthday

ON this, the 30th anniversary of the Association, it is quite fitting that due recognition be given the founders of an idea which has proven of inestimable value to the iron and steel industry. At an informal meeting of some 20 electrical engineers held in Pittsburgh in 1907, a proposal was made that an Association of electrical engineers of the Iron and Steel Industry be formed with the idea that, by the cooperation of the members, this branch of engineering in the industry could be advanced.

Within a period of a few years the membership of the Association was fairly representative of the industry. In 1910 a proposal was adopted to include the section designated as associate members, including those indirectly interested such as equipment, general supplies, and service representatives. This was a further development of the idea of cooperation, as the engineers appreciated more and more the value of interchange of ideas and engineering data, such as was afforded by their opportunity to visit the different mills and make additional personal contacts. A rapid advance in the design of machinery, with increased usefulness and efficiency, soon became apparent.

Today the modern steel plant is practically universally electrified and, during the period of its development, electrical engineering became closely identified with every department and branch of engineering in the steel industry. This intimate and valuable contact made it evident that the activities had outgrown the name of the Association of Iron and Steel Electrical Engineers and in August 1936, a broader designation, namely Association of Iron & Steel Engineers, was adopted embracing practically all departments, electrical, mechanical, metallurgical, combustion, lubricating and welding.

In addition to two national yearly meetings, the Association holds winter meetings in five different sections, viz: Pittsburgh, Chicago, Cleveland, Philadelphia and Birmingham. During the 30 years of its existence, more than 1,000 technical papers have been presented. As most of them have been based on a practical knowledge of the subject, gained from experience and engineering study, a high reference value of the papers has been established. The Iron & Steel exposition, a feature of the annual convention, keeps the industry fully informed of the latest developments and practices.

The Association has grown to be of international character, with representatives in 21 foreign countries, viz.: Australia, Canada, China, Czechoslovakia, England, France, Germany, Holland, India, Japan, Manchuria, Mexico, Rumania, Phillippine Islands, Scotland, South Africa, South America, Spain, Sweden, U. S. S. R., and Wales.

Two of the most outstanding achievements of the Association are, first—that it was the principal factor in the development of electrical engineering in the steel industry. This has been one of the most helpful factors in advancing the design and practices of the mills to the present day high standard. Second, the Association sponsored the formation of the National Safety Council, which occurred 25 years ago. A program, commemorating the development of the National Safety Council idea, is arranged for the next annual convention of the Association, to be held at the Stevens Hotel, Chicago, the latter part of September.

It will thus be seen that much credit is due the charter members of the Association for it was their vision and faith in what seemed to them a practical and logical procedure, the results of which have been of much value to the industry. The Association looks forward to a gradual expansion of its usefulness as its membership broadens, and becomes more and more representative of all branches of the industry's activities.

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- Contacts are changed every six to seven weeks.
- Arc Shields show no destructive burning.

PREVIOUS CONTACTOR

- Contacts were changed every 24 to 48 hours, depending upon the frequency of operation.
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EC&M 600 Ampere LINE-ARC Magnetic Contactor installed on severe duty butt-welding application.

- After 9 months of continuous operation (making 28 operations per minute, 24 hours per day, 7 days a week), this contactor is still equipped with the original contacts and arc shields.

PREVIOUS CONTACTOR

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EC&M LINE-ARC Magnetic Contactor installed as Main Line Contactor on 40" Blooming Mill Screwdown 100 HP Controller.

- Contacts were changed after two million operations (approximately 7½ months service).
- Arc Shields in excellent shape—sides of shields absolutely smooth.

PREVIOUS CONTACTOR

- Contacts were changed about every two months.
- Arc Shield Inserts were replaced about every month.

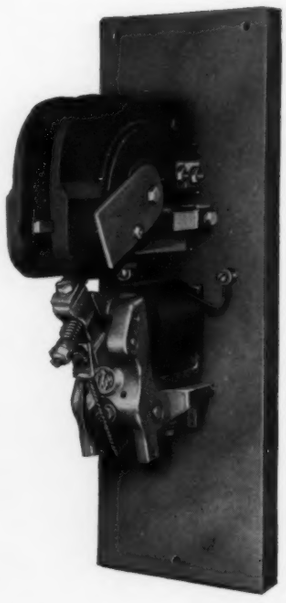
Specify these EC&M LINE-ARC MAGNETIC CONTACTORS when buying Motor Control, Welding Machines, etc.

Every delay is a production problem for it affects output, operating cost and profit. Better profits result from fewer interruptions—less expense for replacement of wearing parts.

In these EC&M LINE-ARC Magnetic Contactors, the scientific method of handling the arc as the circuit is ruptured has established a new low in operating costs—has materially lengthened the life of contacts—and has prevented destructive burning of the arc shields.

The three service records given above of these EC&M LINE-ARC Magnetic Contactors under unusually severe conditions are representative of the outstanding results and improved performance that hundreds of these contactors are giving today. Many reports of other installations show even a greater improvement over previous performance—and some records are still in the making.

Investigate these highly efficient contactors today. Write for the Bulletins listed at the right which give complete description, ratings of each size, weights, dimensions, etc.



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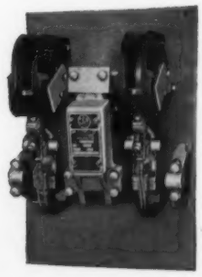

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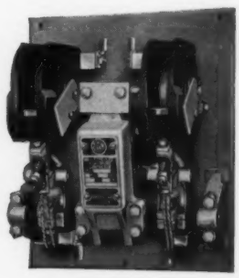

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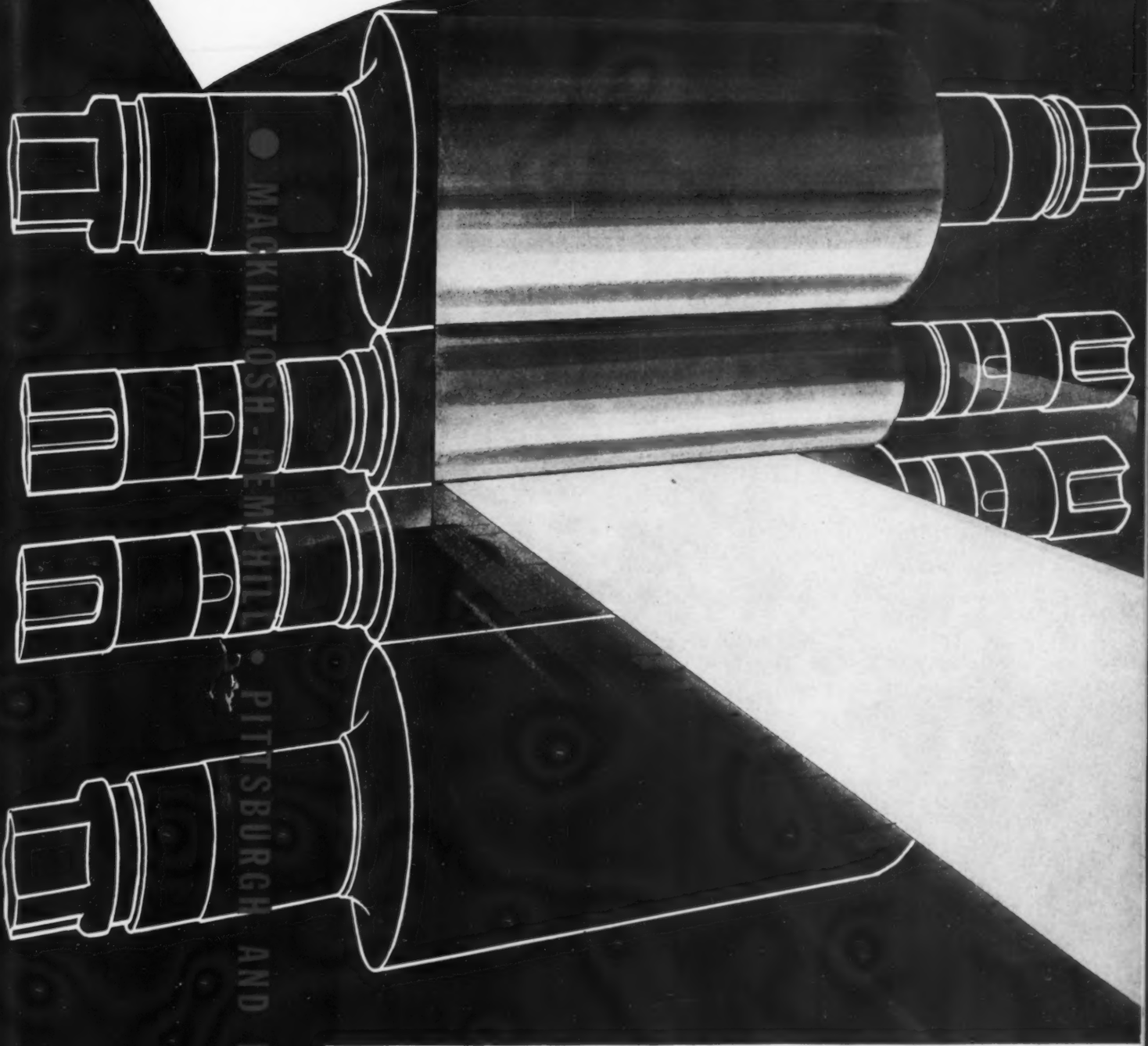

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Review of Spring Conference held in Buffalo

Over one thousand steel mill engineers attended the spring engineering conference sponsored by the Association in Buffalo, N. Y., April 28–29. Every steel mill geographic section was well represented for this annual meeting.

A total of five papers were presented beginning Wednesday with one on the subject of "Radiant Tube Annealing Covers" by R. J. Cowan, Surface Combustion Corp., and another on "Electrical and Mechanical Developments of Modern Cold Strip Mills" by John L. Young, United Engineering and Foundry Company and A. F. Kenyon, Westinghouse Electric and Manufacturing Company.

The Thursday morning session was opened by Martin J. Conway discussing the subject of "Some Heating Furnace Control Problems followed by F. H. Craton of the General Electric Company presenting a paper on "Diesel Electric Locomotives in Steel Mill Service" and the sessions were concluded with E. W. P. Smith of the Lincoln Electric Company discussing the subject of "Simplicity of Stress Distribution in Arc Welded Joints."

Thursday afternoon a calvacade of buses transported the members out to the Lackawanna plant of the Bethlehem Steel Company where they had the opportunity of inspecting Bethlehem's new continuous mill.

J. A. Clauss, chief engineer, Great Lakes Steel Corp., who was chairman of the Wednesday evening technical session, talks over the highlights of the meeting with H. G. R. Bennett, assistant general superintendent, Carnegie-Illinois Steel Corp., Duquesne, Pa., and president of the Association.

A. F. Kenyon, Westinghouse Electric & Manufacturing Company and John L. Young, United Engineering & Foundry Company who presented a paper entitled "Electrical and Mechanical Development of Cold Strip Mills", at the Wednesday evening session.

6 More PIT TYPE Furnaces

For Annealing Wire and Normalizing Rod

The above installation—another repeat order—is one of several pit type furnace installations recently completed or now under construction for normalizing rod and bright annealing steel wire.

Recently we have been favored with repeat orders from several of the most prominent rod and wire mills in the country for these pit type annealers and normalizers.

These repeat orders include additional furnaces ranging from one to six per installation. Some are for annealing wire only, some for normalizing and spheriodizing rod and others are to be arranged for handling both rod and wire in the same equipment.

These furnaces are fired with coke oven gas, mixed gases, natural gas or fuel oil.

All are being arranged for use with Elfurno controlled atmosphere because surface condition is becoming so increasingly important.

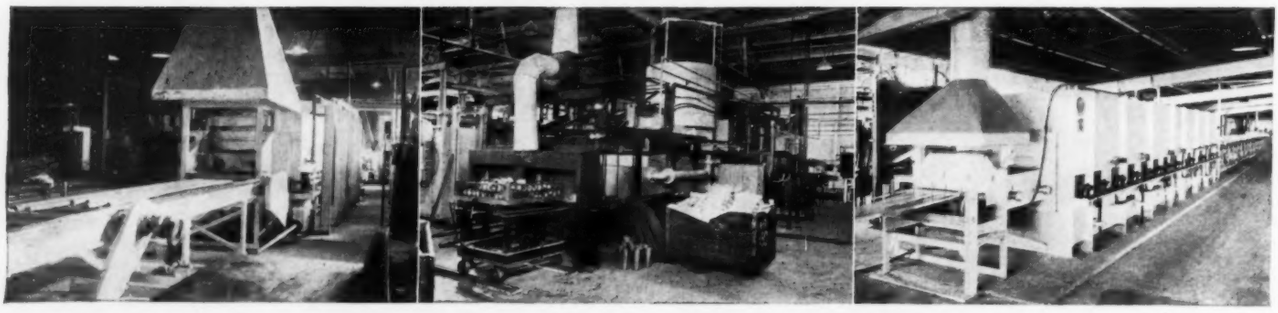
These repeat orders—from users with one and two or more years experience in the operation of the original installation—would seem to indicate that the original furnaces have given satisfactory service and confirm our claim that "these furnaces turn out the most tonnage at the lowest cost with the most satisfactory surface condition obtainable and with the greatest flexibility of operation."

Other recent installations include furnaces for bright annealing copper wire, steel and copper tubing, strip, stampings, clean annealing brass wire, scale free hardening bolts, springs and miscellaneous products, as well as furnaces for billet heating, carburizing, copper brazing and other heating and heat treating processes.

Additional information on these pit type annealers and normalizers or on any other types of furnaces gladly furnished on request.

The Electric Furnace Co., Salem, O.

We Build the Furnace to Fit Your Job — For Oil, Gas or Electric Heat.



Bright Annealing Steel Tubing—Continuously

Bright Annealing Stampings—Continuously.

Bright Annealing Steel Strip—Continuously.

THE CONTINUOUS ROLLING of Hot Strip Steel *

By AUGUST F. GIESE, JR.
GARY, INDIANA

Presented before the National Meeting A. I. & S. E., Youngstown, Ohio, February 25, 1937.

▲ FROM the small beginning of less than a score of years, the continuous rolling of strip steel has developed into a gigantic affair with truly formidable equipment.

The various members directly concerned with the continuous process will be enumerated and described as we proceed with the article.

We will take for example the operation of a 76″ mill, which consists of the following rolling stands.

ROUGHING TRAIN

Mill	Roll Size	Roll Speed
No. 1-Scale Breaker	23″ x 76″	42.27 R.P.M.
No. 1-Roughing Mill	36″ x 49″ x 95″	19.118 "
No. 2-3-4-Roughing Mills	25″ x 49″ x 77″	64. "

FINISHING TRAIN

No. 2-Scale Breaker	24″ x 76″	16.90-to-50.75 R.P.M.
No. 5-Finishing Stand	24½″ x 49″ x 77″	27.625-to-58. "
No. 6- " "	24½″ x 49″ x 77″	43.75-to-91.2 "
No. 7- " "	24½″ x 49″ x 77″	59.4-to-123. "
No. 8- " "	24½″ x 49″ x 77″	76.4-to-159. "
No. 9- " "	24½″ x 49″ x 77″	91.5-to-192. "
No. 10- " "	24½″ x 49″ x 77″	105.5-to-219.8 "

The process of continuous rolling of strip steel consists primarily of charging a slab of steel into the back end of a heating furnace which may be fired by either oil or gas.

It is always desirable to roll the maximum size of slab that can be heated in the furnace and handled to good advantage in the roughing mills, and while at times it is essential to charge hot as well as cold slabs, it should be kept in mind that a hot charged slab will not descale as readily as one that has been charged cold.

*Copyrighted 1937 by August F. Giese, Jr.

In the spreading or cross rolling of slabs for width it is very important to have the slab as nearly free from scale as is consistent with good practice, for a partially descaled slab will slip in the spreading stand or No. 1 mill, especially when using a heavy draft which is necessary at times to produce the proper width.

The heating furnaces are designed for bringing the slab up to a good rolling temperature and at the same time produce a scale which can be readily removed by the scale breaker and the hydraulic sprays in the roughing mills.

The heating of the steel is done from the hearth toward the back end of the furnace while the soaking takes place on the hearth.

The furnaces used in connection with the mill described are of the oil, air primed, regenerative type with a hearth length of 16′ 4″ and a heating zone of 60′–7″ x 18′ in width.

In some furnaces the hearth consists of the old conventional fire brick and steel skid construction, the steel skids being nothing more or less than 4″ x 10″ billets which are set edge up and are a continuation of the cold water skid that stops at the approach side of the hearth. These billets are bricked in up to 1½″ from the top which forms the hearth, however, it has been found through actual experience that this arrangement is directly responsible for many pile ups that are caused by loose scale which adheres and burns fast to the hot skid.

AUGUST F. GIESE, JR.

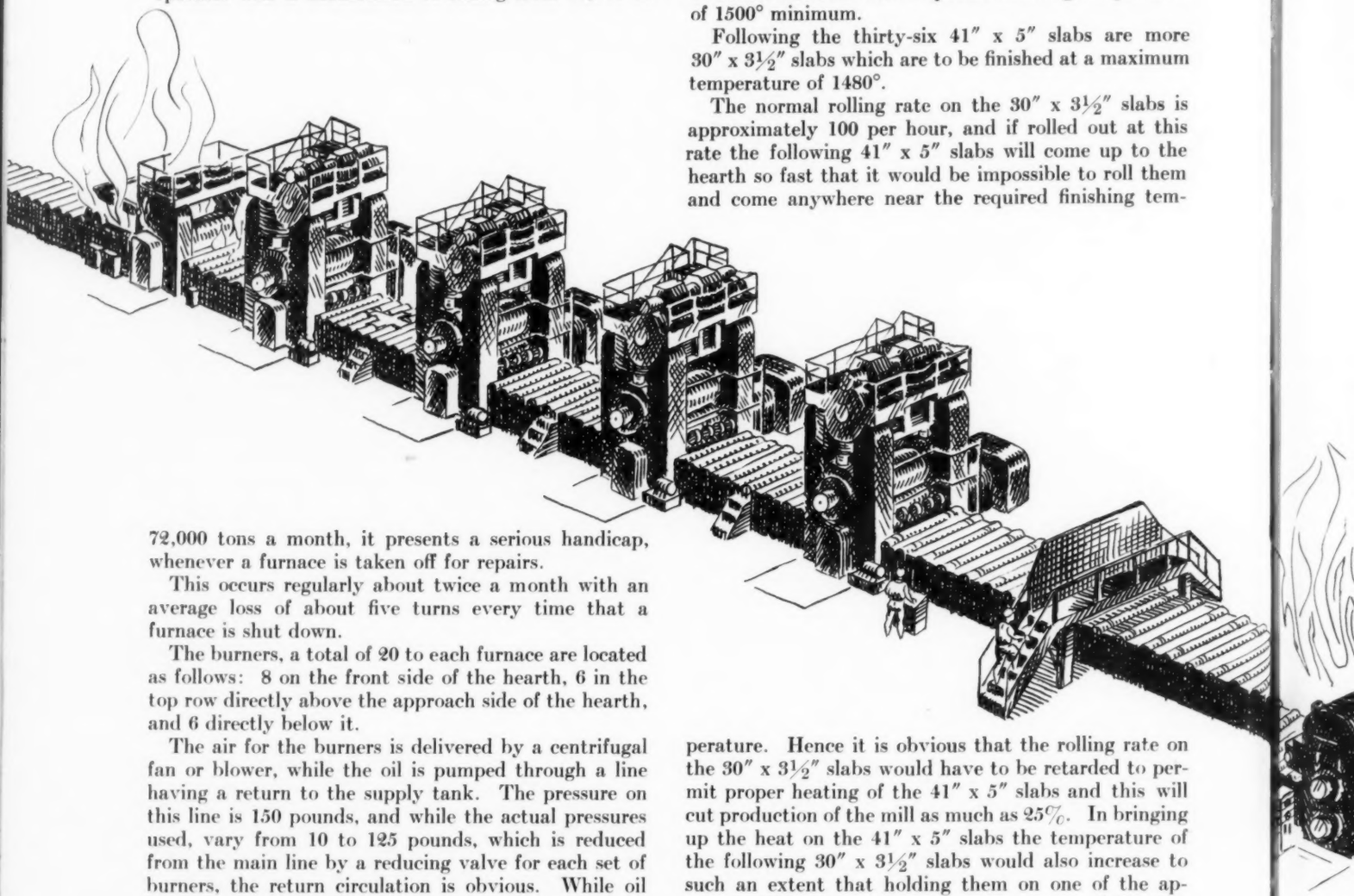
It has been found necessary to clean off this scale accumulation as often as once a turn, four or five days a week, and the life of such an arrangement has never been more than 100,000 tons of steel rolled.

A later development which eliminates practically all of this trouble and which is good for approximately 600,000 tons of steel rolled, consists

merely of eliminating the steel billet from the hearth, lowering the top elevation of the brick work about 4″ and making up this difference with a coating of chrome ore.

The cost of this construction is practically negligible when compared with the troubles and lost time encountered on a steel and brick type hearth. The actual cost of covering a hearth 16′–4″ long and 18′ wide to a depth of 4″ with chrome ore is $564.00.

The heating equipment consists of three furnaces which may appear adequate, but to the experienced operator who is accustomed to rolling from 67,000 to 72,000 tons a month, it presents a serious handicap, whenever a furnace is taken off for repairs.



This occurs regularly about twice a month with an average loss of about five turns every time that a furnace is shut down.

The burners, a total of 20 to each furnace are located as follows: 8 on the front side of the hearth, 6 in the top row directly above the approach side of the hearth, and 6 directly below it.

The air for the burners is delivered by a centrifugal fan or blower, while the oil is pumped through a line having a return to the supply tank. The pressure on this line is 150 pounds, and while the actual pressures used, vary from 10 to 125 pounds, which is reduced from the main line by a reducing valve for each set of burners, the return circulation is obvious. While oil firing is approximately 40% cheaper than producer or coke oven gas the refractory cost is much higher, oil firing burns out the brick work and if directed on the steel itself will burn it.

Another advantage of gas firing is that it is much easier to control than oil and results in a more uniform temperature which is a very important factor in the rolling of strip steel.

The draft and oil pressure on the burners vary considerably with the size of the slab which is being heated. On light slabs around 3 inches thick, the pressure on the back burners runs around 25 pounds with 10 pounds on the hearth burners, and a four inch draft.

On slabs around 41 x 5″ the pressure on the back burners is 125 pounds with 10 pounds on the hearth burners and a draft of 18″.

From the foregoing it can readily be seen that great care should be exercised in lining up the mill so to avoid as much as possible the charging of light slabs between the heavier or thicker ones or vice-versa.

In order to emphasize the importance of proper charging in relation to heating, we will say that the first 17 slabs on each of the six skids are 30 x 3½″ which are to be rolled into flats. The next order charged consists of six 41″ x 5″ slabs on each skid which are to be rolled into coils with a specific finishing temperature of 1500° minimum.

Following the thirty-six 41″ x 5″ slabs are more 30″ x 3½″ slabs which are to be finished at a maximum temperature of 1480°.

The normal rolling rate on the 30″ x 3½″ slabs is approximately 100 per hour, and if rolled out at this rate the following 41″ x 5″ slabs will come up to the hearth so fast that it would be impossible to roll them and come anywhere near the required finishing temperature. Hence it is obvious that the rolling rate on the 30″ x 3½″ slabs would have to be retarded to permit proper heating of the 41″ x 5″ slabs and this will cut production of the mill as much as 25%. In bringing up the heat on the 41″ x 5″ slabs the temperature of the following 30″ x 3½″ slabs would also increase to such an extent that holding them on one of the approach tables for cooling so as to come within the maximum finishing temperature of 1480° would be necessary.

Charging of this nature is common practice in some mills and only results in a bad product and curtailed production.

In going from a slab 41″ wide to one that is 55″ wide the rolling rate must be slowed up considerably in order to compensate for the shorter length of time that it takes the wider slab to travel through the furnace.

It is known generally that with a good section and proper heating it is possible to roll as high as 130 slabs per hour, however, when on a section requiring a 5700 pound slab with a minimum finishing temperature of

1500° the rolling rate is slowed up considerably, but with good steady heating and barring delays, it is possible to roll from 70 to 75 slabs per hour with an approximate tonnage of 1460 tons per turn.

In order to give a little insight into what may be expected when the furnaces are working properly the following temperatures, which are actual, are given.

Temperature of slab at No. 1 mill.....2170°
No. 1 furnace-mill working.....Temperature
Wall at second door from front.....2440°
Edge of slab.....2328°
Wall at third door.....2402°
Edge of slab.....2290°
No. 1 furnace-mill down
Hearth wall—2458°.....edge of Slab—2320°
No. 1 door wall—2430°..... " " " —2320°
No. 2 " " —2367°..... " " " —2304°
No. 3 " " —2280°..... " " " —2280°

The oil burned in these furnaces on a record run of 70,119 tons for one month totaled 840,880 gallons with an average of 12 gallons per ton. The total cost of oil consumed was $23,694.00 at a cost of $0.338 per ton.

Having given a brief description of the heating furnaces we will now proceed with the operation of the Roughing Mills.

The No. 1 Scale Breaking Stand is of the two high type with a hydraulic spray system of ample capacity with pressures ranging from 900 to 1200 pounds. The rolls are of smooth alloy steel and function primarily as a set of pinch rolls to maintain a constant speed through the hydraulic sprays. Usually an eighth-inch of draft on this mill is ample pull to loosen the scale.

When charging hot steel it has been found that by fluting the top roll, the removal of scale is greatly facilitated. The spray nozzles etc., have been standardized to quite an extent and give very little trouble under ordinary rolling conditions.

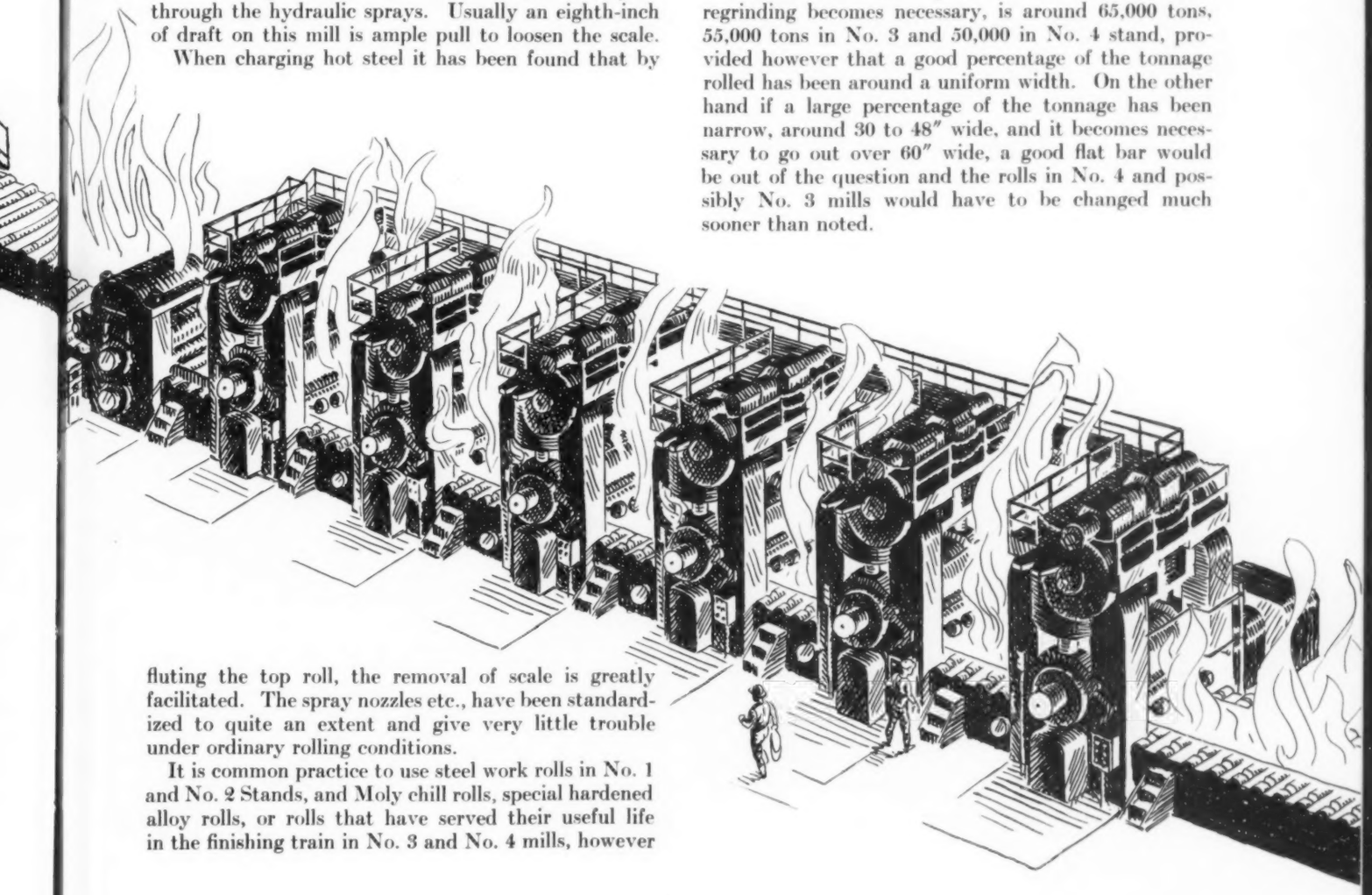
It is common practice to use steel work rolls in No. 1 and No. 2 Stands, and Moly chill rolls, special hardened alloy rolls, or rolls that have served their useful life in the finishing train in No. 3 and No. 4 mills, however it has been found in practice that, cromonite rolls around 24″ break more easily in No. 2 and No. 3 stands than a Moly chill roll will under the same working conditions.

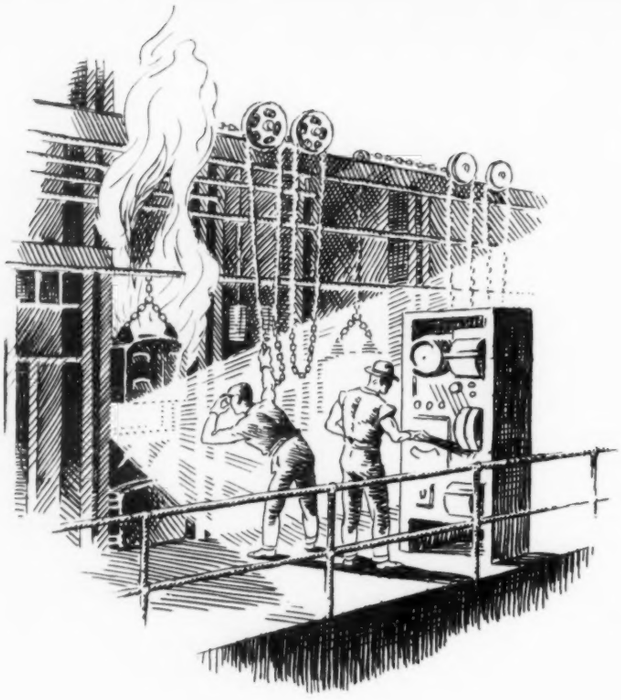
The back up rolls in No. 1 to No. 4 mills inclusive are ground straight, and tonnages up to 100,000 tons have been rolled on No. 1 stand before changing either work or back up rolls, with no appreciable bad effects in the rolling practice. This also applied to the No. 1 Scale Breaker rolls.

The work rolls in No. 2 and No. 3 stands are usually changed every week end with an approximate tonnage of 15,000 tons, however if 6,000 or 7,000 tons of narrow steel (under 48″ wide), have been rolled the first three or four days of the week and it becomes necessary to go out over 60″ wide the work rolls in No. 3 stand and possibly No. 2 stand would have to be changed in order to obtain a flat bar of uniform cross section with a good square leading edge.

No. 4 mill work rolls are usually taken out on every general roll change when, after finishing up on a narrow section of say about 36″ and in going out to 50″ wide after the general change. When enough steel has been scheduled so the rolling width remains practically the same for 16 or 24 hours the work rolls in this mill are good for around 1500 to 2000 tons, before the surface will be effected in any way. The condition of the surface is very seldom effected by the work rolls in No. 4 mill up to 1000 tons.

The life of the back up rolls in No. 2 stand, before regrinding becomes necessary, is around 65,000 tons, 55,000 tons in No. 3 and 50,000 in No. 4 stand, provided however that a good percentage of the tonnage rolled has been around a uniform width. On the other hand if a large percentage of the tonnage has been narrow, around 30 to 48″ wide, and it becomes necessary to go out over 60″ wide, a good flat bar would be out of the question and the rolls in No. 4 and possibly No. 3 mills would have to be changed much sooner than noted.





The roll set up on the roughing mill is as follows:

WORK ROLLS

No. 1-Scale Breaker.....	23″ x 76″	Ground straight
No. 1-Mill.....	36″ x 95″	Ground straight
No. 2-Mill.....	25″ x 77″	.015″ crown on top roll
No. 3-Mill.....	25″ x 77″	" " " " "
No. 4-Mill.....	25″ x 77″	" " " " "

All bottom rolls in No. 2, 3 and 4 mills are ground straight.

The minimum roll diameter in No. 2, 3 and 4 mills is 23.300″.

BACK UP ROLLS

No. 1-Mill.....	49″ x 95″	Ground straight
No. 2-Mill.....	49″ x 77″	" "
No. 3-Mill.....	49″ x 77″	" "
No. 4-Mill.....	49″ x 77″	" "

The roll balance pressure is 2200 pounds and a soluble oil, composed of 30 gallons of water to one gallon of oil is used.

A standard grade "O" oil is used for lubricating the pinion stands and the capacity of this system is 10,000 gallons. Voco-1.2 grease is used on the roller bearings of the rolls.

The function of the vertical edging mills will be described in the operation of the roughing stands.

Analysis of Work Rolls

Moly chill, approximate average life of roll 90,000 tons.

Scleroscope 65.

Tc.	Mn.	Si.	S.	P.	Cr.	Ni.	Mo.
2.94	.32	.68	.091	.514	.13	...	.22

Back up Rolls

Heat treated Alloy Steel.

Approximate average life of roll, 1,000,000 ton.

Scleroscope 42.

C.	Mn.	P.	S.	Si.	Cr.	Ni.	Mo.
1.06	.51	.042	.026	.51	.67	.82	...
			Special Steel				
1.56	1.42	.080	.047	.47	1.12	.71	.26

A late development for preventing slipping in No. 2 and No. 3 stands without fluting the work rolls, merely consists of acid etching. The solution used, consists of two parts of nitric acid to one part of water, which is mixed in a shallow semi-circular acid proof trough which is set on a stand, constructed in such a manner that when the bearings are assembled on the roll necks and set on the stand the bottom of the roll is free to turn in the acid solution. A hand crank is assembled on one of the necks by which the roll is rotated slowly in the acid. As soon as the etching becomes noticeable the roll is taken off of the stand, washed with cold water and wiped dry to prevent further action of the acid.

The squeezer is a very powerful machine and is almost indispensable when spreading or cross rolling for width. The operation is quite simple and is very easily over done which results in upset edges that terminate into long ears and irregular width on the head ends, back ends, or both, on the finished strip.

Proper manipulation of the various units in the roughing train have a far reaching effect in the elimination of cobbles in this train as well as in the finishing train, and is also the determining factor in producing a section of uniform width.

Before starting on the actual rolling of slabs, a few words in regards to lining up the mills may be helpful.

The pass line or top elevation of the bottom work roll is normally 1½″ above the table rolls.

After the mill has been in operation for some time the diameter of all of the rolls decrease and after a while it becomes necessary to make up this difference by using liners under the back up rolls. Unless the mills are kept up to proper elevation many costly delays and broken rolls will be encountered.

A simple check on the pass line when changing the work and back up rolls can be made as follows. Assume that the theoretical pass line of the mill being changed is 96″. The roll set up in mill at this time follows. The thickness of liner under the bottom back up chock is 3.179″; the distance from bottom of chock to center line of bottom back up roll is 2′ 9½″ with a diameter of 34.656″ for the bottom work roll and 48.565″ diameter on the bottom back up roll. These diameters are on the rolls that are to be changed. The new rolls which are to be put into the mill are 35.500″ diameter on the work rolls and 48.795″ on the back up rolls.

The difference in the new liner required is as follows:

New Rolls		Old Rolls
35.500″	Work Roll Diameter	34.656″
24.397″	½ diameter bottom back up	24.282″
59.897″		58.938″

59.897″ new rolls
58.938″ old rolls

.959″ difference

58.938″ = height of old rolls
33.500″ = distance from bottom of chock to center line of bottom roll
3.179″ = thickness of present liner

95.617″ = height of present pass
3.179″ = Thickness of old liner
.959″ = Difference in roll diameter

2.220″ = Thickness of new liner
59.897″ = height of new rolls
33.500″ = distance from bottom of chock to center line of bottom roll
2.220″ = thickness of new liner

95.617″ = height of pass

The approximate draft used on the roughing mills in straight away rolling is as follows:

SETTING OF MILLS

Slab Thickness	No. 1	No. 2	No. 3	%
3.00	2100	1470	1030	30
3.25	2240	1550	1070	31
3.50	2380	1620	1100	32
3.75	2510	1680	1130	33
4.00	2640	1750	1150	34
4.25	2760	1800	1160	35
4.50	2880	1840	1180	36
4.75	2990	1880	1190	37
5.00	3100	1920	1200	38
5.25	3200	1950	1200	39
5.50	3300	1980	1200	40
5.75	3400	2100	1250	41–38–40%
6.00	3500	2200	1300	42–37–41%
6.25	3550	2250	1300	43–37–42%
6.50	3600	2300	1350	45–36–40%

The setting of No. 4 mill is from .650″ to .850″, according to the required temperature for finishing out of No. 10 mill.

In cross rolling for width the draft on No. 1 mill is figured as follows: 3″ is always added to the required finished width as this much stock is needed for the squeeze to true up the edges.

Slab size—40″ x 5″.

Rolling width 49″—(Required finished width).

49″ + 3″ (for squeeze) = 52″.

∴ 40″ x 5″ = 200″ ÷ 52″ = 3846 = setting of No. 1 mill.

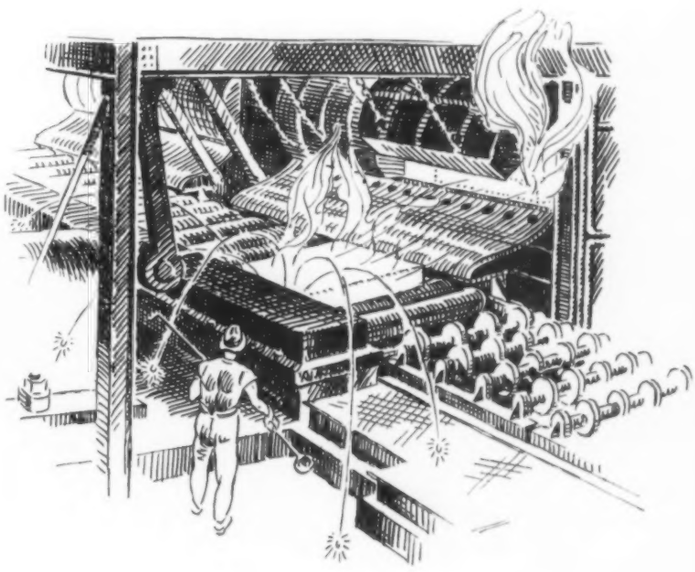
Following is a typical start up schedule after a shut down, repair turn, and in using the above table to figure the draft on No. 1 to No. 3 mills inclusive, the drafting of the roughing mills follows.

The work rolls in No. 2 to 10 mills inclusive, and back up rolls in Nos. 2-4-6-9 and 10 mills were changed on the shut down and 50″ was the maximum width on this rolling.

Section	Slab Size	Setting	No. 1	No. 2	No. 3
24⅝″ x .109	25 x 3		2400	1800	1320
30⅝″ x .107	32 x 4		2700	1950	1320
31¾″ x .107	32 x 4		2700	1950	1320
30⅝″ x .140	32 x 4		2700	1950	1320
31 ″ x .219	31 x 4½		3050	2100	1350
31½″ x .375	32 x 4½		3050	2100	1350
33½″ x .375	33½ x 4½		3200	2200	1350
49″ x .375	49 x 3½		2600	2000	1350
50 ″ x .375	50 x 5		3200	2200	1350
48¾″ x .188	49 x 4		2700	2100	1350
48¾″ x .138	40 x 4	x roll	3070	2200	1350
48⅝″ x .107	49 x 4		2700	2100	1350
47⅜″ x .078	47½ x 3½		2500	2000	1350
42¾″ x .107	40 x 4	x roll	3500	2350	1380
42¾″ x .138	36½ x 4	x roll	3190	2200	1350

Usually in starting up the mill, after changing No. 1 scale breaker, work and back up rolls in No. 1 mill, No. 2 to No. 10 work rolls and No. 4 back up rolls, it is well to go out to the widest section gradually in order to wear the rolls in properly and which policy, if adhered to, will prevent many costly breakdowns and delays.

The following lineup will afford ample wearing in, assuming however that the widest slab available is 41 inches.



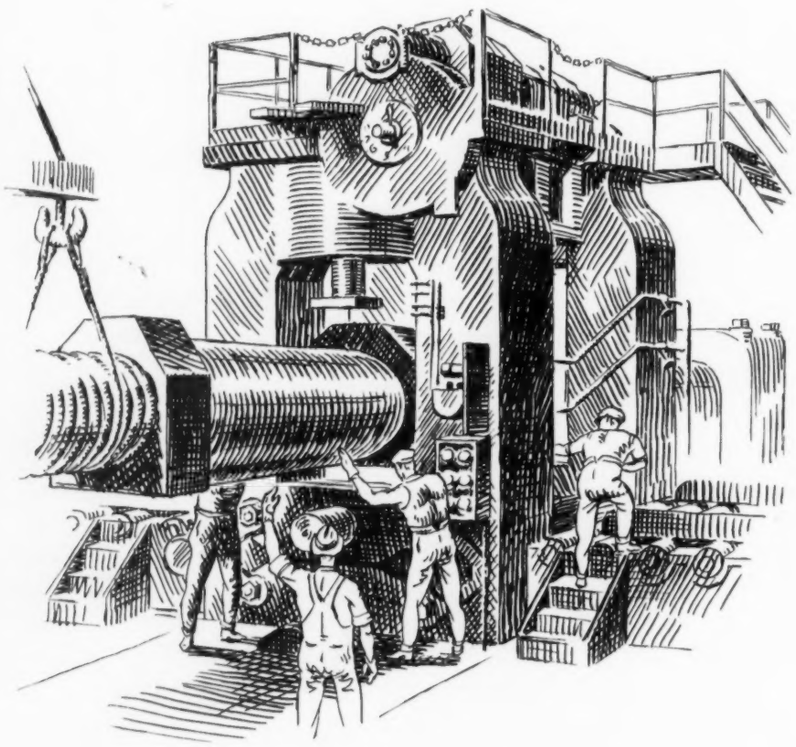
First 1000 tons-up to 41″ wide.

Second 2000 tons-up to 48″ wide.

Third 3000 tons-up to 70″ wide and after this out to 74″.

This appears to be more tonnage than what is actually required, and while there have been times when the maximum width was attained in eight or nine hours after the start up, this can be credited largely to good luck and is not representative of the broken rolls and spindles that are most usually encountered in trying to crowd the mill too quickly.

The vertical edging rolls are of alloy steel, 22″ in diameter and are operated, so that the lineal speed is equal to that of the work rolls.



No. 2 mill edging guides have no top flange and the entry clearance is around 4½″. The edging mills on No. 3 and No. 4 mills have both upper and lower flanges and the entry clearance is 2.7″ and 1.7″ respectively.

The squeezer limits are 36 to 76″ without side rails and 18″ to 60″ with side rails and extra fillers.

The shortest length slab that will enter No. 2 mill must be at least 67″ long as the distance from center line of work roll to center line of vertical roll is 66″.

The set up on the edging mills, when the slab size is larger than the section size follows, and the stock is removed a little at a time in each mill. This set up is used only on coils as the head end will be narrow for about five feet.

Example No. 1

Section 36″ x .061″ Slab size 36½″ x 4″.
Vertical roll setting.
No. 2 mill—36⅛″ No. 3—35⅞″ No. 4—35¾″

The following set up is used where the slab size and set up size are alike and also where the edges are not to be overworked, such as in pure iron where heavy working tends to crack the edges. It is also used on cross rolling where a thick slab is delivered from No. 1 mill and also on 6″ slabs where the excessive spread does not permit the use of a converging set up.

Example No. 2

Section 36¾″ x .061″
Slab size 36½″ x 4″
Vertical roll setting.
No. 2 mill—36½″
No. 3—36⅛″ No. 4—36½″.

The following set up is used on rolled edge sections, on flat strip, where a uniform width is essential, and eliminates the narrow head end.

The setting on No. 2 and No. 4 mills are the same while No. 3 mill is set just wide enough to carry the bar through to the work rolls, about 3/16″ to ½″ wider than No. 2 mill, depending on the spread coming from this mill.

Example No. 3

Section 36¼″ x .061″—Rolled Edge—slab size 36″ x 4″.
Vertical roll setting.
No. 2 mill—36″
No. 3—36 7/16″ No. 4—36″.

The set up used when the bar is delivered from No. 3 mill, under 1″ thick or where the slab size is less than the section size, is as follows.

The vertical rolls are set just wide enough to take care of spread from the previous mill.

Example No. 4

Section 36¾″ x .061″ Slab size 36″ x 4″.
Vertical roll setting.
No. 2 mill—36 5/8″ No. 3—36½″ No. 4—36 5/8″.

Following is a list of drafts and the setting of vertical rolls on various sections, with resulting width.
18 gage—36½″ wide. Slab size—36½″ x 4″.
Vertical roll setting.
No. 2 mill—36 5/16 No. 3—36 3/16″ No. 4—36 1/16″.
Setting No. 1 mill—2800 No. 2—2000 No. 3—1300.
Finished width—Head end 7/16″ over
Back end 5/8″ over
Section 36¼″ x .049″ .18 Ga. Slab size 37″ x 4″.

Squeezer setting—36¼″.
Vertical rolls.
No. 2 mill—36⅛″ No. 3—36″ No. 4—35⅞″.
Setting No. 1 mill—2800 No. 2—2000 No. 3—1300.
Finished width—Head end 7/16″ over
Center Strip ½″ over
Back end ½″ over
Section 26¾″ x .049″ Slab size 26½″ x 4″.
Vertical roll setting.
No. 2 mill—26½″ No. 3—26½″ No. 4—26⅜″.
Setting No. 1 mill—2800 No. 2—2000 No. 3—1300.
Finished width—Head end 7/16″ over
Back end ½″ over
Section 32″ x .061 rolled edge Slab size—32″ x 3″.
Vertical roll setting.
No. 2 mill—31¾″ No. 3—32⅛″ No. 4—31¾″
Setting No. 1 mill—2500 No. 2—1750 No. 3—1150.
Finished width—Head end ⅜″ over
Back end ½″ over

Flats

Section 32⅝″ x .061″ Slab size 34″ x 3″.
Squeezer setting—32¾″.
Vertical roll setting.
No. 2 mill—32⅝″ No. 3—32⅞″ No. 4—32⅝″
Setting No. 1 mill—2400 No. 2—1750 No. 3—1150.
Finished width—Head end ½″ over
Back end ⅝″ over

Flats

Section 62″ x .061″ Slab size 40″ x 4″.
Squeezer setting 62⅜″.
Vertical roll setting.
No. 2 mill—62⅛″ No. 3—62⅛″ No. 4—62⅛″.
Setting No. 1 mill—2460 No. 2—1800 No. 3—1200.
Finished width—Head end 9/16″ over—
Back end ¾″ over

Coils

Section 34½″ x .095″ Slab size 33½″ x 6″.
Vertical roll setting.
No. 2 mill—34½″ No. 3—34½″ No. 4—34½″.
Setting No. 1 mill—3400 No. 2—2100 No. 3—1250.
Finished width—Head end 7/16″ over
Back end ½″ over

Coils

Section 62½″ x .095 Slab size 41″ x 5″.
Squeezer setting 62⅞″.
Vertical roll setting.
No. 2 mill—62¾″ No. 3—62¾″ No. 4—62¾″.
Setting No. 1 mill—3130 No. 2—2000 No. 3—1300.
Finished width—Head end ½″ over
Back end ¾″ over

The setting of No. 4 mill is usually from .650″ to .850″ according to the required finishing temperature out of No. 10 mill.

In the rolling of strip steel, occasionally for no apparent good reason whatever certain variations in the width are encountered.

This condition may become manifest in narrow head, center or back ends, all of which are most usually caused by improper setting of the squeezer or vertical edging mills. However this condition may also originate from improper drafting, or pulling the strip between the various stands in the finishing train.

Most usually when the cause is not readily diagnosed it is well to start with the strip as it comes from the last roughing mill. In checking the width of the strip at this point it can readily be determined if the roughing mill or the finishing train is at fault. If the strip is narrow at various points as it is delivered from No. 10 mill and a check on the head, center, and back ends out of the last roughing stand show ample width, it is pretty certain that the variation is coming from the finishing train.

The following table gives the width out of No. 10 stand as compared with the width out of No. 4 mill, which was an actual test.

Section 59¾″ x .093.

	Out of No. 4 Mill	Out of No. 10 Mill
Piece No. 1	60⅞″	60 13/16″
2	60¾″	60¾″
3	60 13/16″	Chewed up
4	60¾″	60⅝″
5	60¾″	60 11/16″
6	60 13/16″	60 13/16″
7	60⅝″	60 13/16″
8	60¾″	60⅞″
9	60¾″	60⅝″
10	60¾″	60 11/16″
11	60¾″	60⅞″
12	60¾″	60⅞″

In the successful operation of the finishing train it is imperative that a good flat strip with uniform cross section and a good square leading edge is delivered out of No. 4 mill.

Proper setting of the squeezer, vertical rolls, and a good set of work rolls in No. 2, 3 and 4 mills, as well as a good hot properly descaled slab out of No. 1 scale breaker, will solve many a perplexing problem.

The roll set up in the finishing train is as follows:

Work Rolls

No. 2 Scale breaker	24″ x 77″	Ground straight
No. 5 Mill	24.5″ x 77″	.010″ crown
No. 6 Mill	24.5″ x 77″	.010″ crown
No. 7 Mill	24.5″ x 77″	.010″ crown
No. 8 Mill	24.5″ x 77″	.007″ crown
No. 9 Mill	24.5″ x 77″	.007″ crown
No. 10 Mill	24.5″ x 77″	.007″ crown

All bottom rolls ground straight

Back up Rolls

No. 5-10 mills inclusive—49″ x 77″—all ground straight.

The work rolls in Nos. 5, 6 and 7 mills are usually Moly chill of 67 scleroscope hardness while No. 8, No. 9 and No. 10 stands are equipped with nickel or chrome chilled rolls with a hardness 75 in No. 8 and No. 9 mills and 85 in No. 10 stand. The scleroscope hardness of the back up rolls is 42.

As the tables of the finishing mills can be raised or lowered, the lining up of the mill when changing rolls, is a much more simple task than that encountered in the roughing mills.

The roll balance pressure is the same as on the roughing stands. The spacing or distance from center to center of the finishing mills is as follows:

No. 4 mill to No. 2 scale breaker	98′ 11″
No. 2 scale breaker to No. 5 mill	14′ 8″
No. 5 to No. 6 mill	18′ 0″
No. 6 to No. 7 mill	18′ 0″
No. 7 to No. 8 mill	18′ 0″
No. 8 to No. 9 mill	18′ 0″
No. 9 to No. 10 mill	18′ 0″

The life of the rolls in the finishing train varies considerably, No. 5, 6 and 7 mills are usually good for 800 or 900 tons depending greatly on the section and grade of steel which is being rolled while Nos. 8, 9 and 10 mills may produce several thousand tons.

The following run will give a fair idea of what can be expected. After a record run of 1012 tons in 8 hours—390 tons were rolled by the following turn (making a total of 1402) at which time the surface showed a rather heavy scale pattern. No. 5 and 6 mills were changed at this time. Started up and rolled 300 tons more which made a total of 1702 tons on Nos. 7, 8, 9 and 10 stands. At this time a light scale pattern was noticeable on the top of the strip, and a change in the drafting of mills was resorted to as follows:

Came down 100 points on No. 4 mill.

Came down 90 points on No. 2 scale breaker.

Came up 100 points on No. 5 mill (which was worn out).

This change cleaned up the surface 100% and 385 more tons were rolled at which time Nos. 5, 6, 7, 8, 9 and 10 mills were changed, making a total of 3087 tons on Nos. 7, 8, 9 and 10 mills, 1402 tons on Nos5 and 6 mills before first change and 685 tons on these two mills at time of second change. The above tonnage was all 13 gage from 65 to 70″ wide.

The back up rolls in No. 10 mill are changed every week end, provided however that a good percentage of the steel rolled has been over 36″ wide with the wider sections being rolled on the first three or four days of the week.

Under the same condition, No. 9 mill will operate for two weeks, while No. 7 and No. 8 mills are changed at between 25,000 and 30,000 tons and No. 5 and 6 mills around 35,000 and 40,000 tons.

If consistent rolling of wide or narrow sections with width variation of only five or six inches, prevail for a period of several weeks at a time, the life of the back up rolls will be considerably longer and it can readily be seen that the number of times that the width varies from narrow to wider sections governs the number of times that it becomes necessary to change the back up rolls in the finishing stands.

Hollow or worn back up rolls are very noticeable when rolling sections such as 13 gage 66″ wide, 16 gage 62″ wide, 18 gage 54″ wide, etc., and frequently it is quite impossible to get the section through the mill. This condition becomes manifest as it causes wavy edges in the delivery of the strip from the stand itself or by chewing up of the strip in the next stand.

Within certain limits this can be corrected by a reduction of draft on the worn out stand but when No. 9 or 10 stands are involved it is poor policy to continue rolling when it is such a simple matter to change the rolls, thereby eliminating a product of questionable character.

Good providing in lining up a strip mill is the governing factor between high and low production, number of roll changes, roll grinding costs, etc.

Broken work rolls are invariably caused by over draft or overheating which is caused by either an insufficient supply of water or starting up too quick on a cold mill. Some of the more frequent surface defects are caused and corrected in the following manner.

Bad surface or rolled in scale most usually comes from Nos. 5, 6 or 7 mills and sometimes from No. 3 or 4 mills, if changing of work rolls is neglected for long periods of time.

Tail marks originate in Nos. 8, 9 and 10 mills and are nothing more or less than imprints from the work rolls which are caused by long ears that originate in the roughing mills, or frequently from off square ends on the slab itself. In correcting this condition it is necessary to change both No. 9 and 10 work rolls.

Split centers and ends are caused by overdraft, worn out rolls, or cold steel, either of which are easily corrected. Scale drags are usually in the form of a light line the length of which varies from 8 to 12 inches and up to several feet in length, terminating in a small ball of scale which is rolled into the strip itself. Drags of this nature are usually caused by a rough guide or one that is not lined up properly, cracked tables, table being out of line with work roll or by a billy roll that is not turning.

Frequent inspection of the strip will expose a surface defect of this nature and prompt location of the cause with immediate correction should follow, as this defect cannot readily be corrected by pickling or other processing.

Scale drags can always be detected while the strip is going through the mill provided however that the roller and rolling crew are continually on the alert for any such defects.

Center buckle in the finished strip is remedied by coming down 5 points on No. 10 mill and going up 5 points on No. 9 mill.

Side buckle is taken care of in practically the reverse manner.

The temperature of the strip while going through

the finishing stands varies with the section being produced, as follows:

16 gage—

Out of No. 4 mill—2050°
Out of No. 5 mill—1806°
Out of No. 6 mill—1736°
Out of No. 7 mill—1663°
Out of No. 8 mill—1590°
Out of No. 9 mill—1520°
Out of No. 10 mill—1450°

54½″ x .093″—

Out of No. 4 mill—2040°
Out of No. 5 mill—1725°
Out of No. 6 mill—1675°
Out of No. 7 mill—1640°
Out of No. 8 mill—1564°
Out of No. 9 mill—1520°
Out of No. 10 mill—1485°

68½″ x .093″—

Out of No. 4 mill—2055°
Out of No. 5 mill—1740°
Out of No. 6 mill—1660°
Out of No. 7 mill—1608°
Out of No. 8 mill—1540°
Out of No. 9 mill—1508°
Out of No. 10 mill—1490°

In the rolling of pure iron particular attention is given to the edges which, owing to the peculiar analysis of the steel, are very prone to crack if the steel is finished too hot. The strip is moved back and forth on the delay table between No. 4 mill and No. 2 scale breaker and checked with an optical pyrometer, until it has cooled down to 1710° at which time it is delivered into the finishing train, and from which it finally emerges at a temperature of 1490°. Water off of No. 2 scale breaker equals 10° higher finishing temperature. One Roll Revolution on No. 5 to 10 mills equals 1° finishing temperature at No. 10 stand, or in other words if the finishing train is speeded up 10 revolutions, the finishing temperature will be 10° higher.

In starting up a new mill the roller must be thoroughly familiar with the gear ratios, the motor and roll speed, percentage of draft, and delivery speed, as well as the multitude of obstacles that may be encountered.

A suitable section, around .120″ to .150″ gage is usually chosen as the start up section and the delivery speed should be around 1,000′ per minute. From the following table all of the necessary information is easily arrived at. Naturally the gear ratio and motor speed are the first items to consider and in the mill which we are discussing, the ratio and motor speeds are as follows:

Ratio	Motor Speed
No. 5 mill .159″	175 to 365 R.P.M.
No. 6 mill .250″	175 to 365 "
No. 7 mill .339″	175 to 365 "
No. 8 mill .437″	175 to 365 "
No. 9 mill .524″	175 to 565 "
No. 10 mill .602″	175 to 365 "

In arriving at the roll speed we have but to multiply the motor speed by the gear ratio and work out the following table:

Pass	Ratio	Top Motor Speed	Low Motor Speed	Top Roll Speed	Low Roll Speed
5	.159″	365 R.P.M.	175 R.P.M.	58 R.P.M.	27.825 R.P.M.
6	.250″	365 "	175 "	91.2 "	43.75 "
7	.339″	365 "	175 "	123.7 "	59.3 "
8	.437″	365 "	175 "	159.4 "	76.4 "
9	.524″	365 "	175 "	191.2 "	91.7 "
10	.602″	365 "	175 "	219.7 "	105.3 "

The lowest delivery from No. 10 mill = 675.5 feet per minute.

The highest delivery from No. 10 mill = 1410 feet per minute.

$$\frac{\text{Roll Diameter} \times 3.1416 \times \text{Roll Speed}}{12} = \text{Feet per minute delivery.}$$

From the above table all of the roll revolutions, corresponding with every 5 motor revolutions, from the minimum to the maximum are carefully figured for each stand and entered in a book for handy reference. The delivery speed of No. 10 mill is also entered for every five roll revolutions, from the minimum to the maximum number of roll revolutions and entered with the roll R.P.M. of that mill.

The draft carried on the finishing stands is most usually within the following range. However, with improper drafting the percentage may vary considerably.

No. 10 Mill..... 4 to 9%
No. 9 Mill.....20 to 25%
No. 8 Mill.....28 to 33%
No. 7 Mill.....33 to 35%
No. 6 Mill.....33 to 35%
No. 5 Mill.....40 to 50%

As a comparison, we will enter the actual reduction on sections that were rolled very recently.

Section 33½″ x .051″

No. 10 Mill..... 9%
No. 9 Mill.....25%
No. 8 Mill.....34%
No. 7 Mill.....35%
No. 6 Mill.....32%
No. 5 Mill.....50%

.049″ Gage		Gage
No. 10 Mill	15%	.049″
No. 9 Mill	27%	.058″
No. 8 Mill	24%	.080″
No. 7 Mill	33%	.104″
No. 6 Mill	52%	.178″
No. 5 Mill	60%	.334″

.850″ out of No. 4 mill
Section 47½″ x .109″

No. 10 Mill..... 4%
No. 9 Mill.....26%
No. 8 Mill.....28%
No. 7 Mill.....29%
No. 6 Mill.....32%
No. 5 Mill.....40%

.120 Gage

No. 10 Mill	9%
No. 9 Mill	20%
No. 8 Mill	23%
No. 7 Mill	31%
No. 6 Mill	36%
No. 5 Mill	38%

To deliver a certain section at a given speed.

Example

Section 28″ x .062″ at 1300 feet.

$$\frac{\text{Delivery Gage x Roll Speed No. 10 Mill}}{\text{Gage No. 9 Mill}} = \text{Speed of No. 9 Mill.}$$

Circumference of 24.5″ roll = 76.969″ or 6.41′.

$$\frac{1300'}{6.41'} = 202.7 = \text{Roll Speed No. 10 Mill.}$$

$$\frac{.062'' \times 202.7}{\text{Gauge No. 9}} = \text{Roll Speed No. 9 Mill}$$

Gauge No. 9 = Roll Speed No. 8 Mill

" No. 8 = Roll Speed No. 7 Mill

" No. 7 = Roll Speed No. 6 Mill

" No. 6 = Roll Speed No. 5 Mill

To get gauge for No. 5-6-7-8 and 9, use the following percentages:

No. 10 Mill	4 to 9%
No. 9 Mill	20 to 25%
No. 8 Mill	28 to 33%
No. 7 Mill	33 to 35%
No. 6 Mill	33 to 35%
No. 5 Mill	40 to 55%

To get the draft and gauge on any section, we have the following:

Example .047″ x 26″.

$$\frac{\text{Roll Speed x Gauge No. 10 Mill}}{\text{Roll Speed No. 9 Mill}} = \text{Gauge No. 9 Mill}$$

Roll Speed No. 8 Mill = Gauge No. 8 Mill

Roll Speed No. 7 Mill = Gauge No. 7 Mill

Roll Speed No. 6 Mill = Gauge No. 6 Mill

Roll Speed No. 5 Mill = Gauge No. 5 Mill

No. 1—213.7 x .047 = 100,439

No. 2—100,439 ÷ 188.6 = .053″ = Gauge No. 9

No. 3—100,439 ÷ 133.3 = .075″ = Gauge No. 8

No. 4—100,439 ÷ 86.5 = .116″ = Gauge No. 7

No. 5—100,439 ÷ 53.7 = .186″ = Gauge No. 6

No. 6—100,439 ÷ 31.0 = .324″ = Gauge No. 5

No. 7—.053—.047 ÷ 53 = 11.3%—Draft No. 10 Mill

No. 8—.075—.053 ÷ 075 = 29.3%—Draft No. 9 Mill

No. 9—.116—.075 ÷ 116 = 35.3%—Draft No. 8 Mill

No. 10—.187—.116 ÷ 187 = 38 %—Draft No. 7 Mill

No. 11—.324—.187 ÷ 324 = 42 %—Draft No. 6 Mill

No. 12—.730—.324 ÷ 730 = 55.6%—Draft No. 5 Mill

.730 out of No. 4 Mill

The roll speeds shown, are actual and from the above the following tables are arranged:

	Motor Speed	Roll Speed	Gage	Draft
No. 5 Mill	195	31.0	.324	55.6%
No. 6 Mill	215	53.7	.187	42 %
No. 7 Mill	255	86.5	.116	38 %
No. 8 Mill	305	133.3	.075	35.3%
No. 9 Mill	360	188.6	.053	29.3%
No. 10 Mill	355	213.7	.047	11.3%

Using the percentages shown, for a section of .120″ at a delivery speed of 983 feet we arrive at the following:

Mill	Actual Gauge	Motor Speed	Roll Speed	Mill Setting	Draft
No. 10	.120	255	153.5	310	9%
No. 9	.132	250	131.0	240	20%
No. 8	.167	250	109.2	300	23%
No. 7	.217	250	84.7	350	31%
No. 6	.315	235	58.7	450	36%
No. 5	.495	235	37.3	620	38%
No. 4	.800				

In drafting the mills all section changes are figured from any set up that has performed satisfactorily in actual practice, and by the old guess and trial method a range between the various gauges is developed for making section changes. The section used is 34½″ x .093″ and the settings used on the mills in producing this section is as follows.

No. 10 Mill = 265 points

No. 9 Mill = 235 points

No. 8 Mill = 255 points

No. 7 Mill = 300 points

No. 6 Mill = 410 points

No. 5 Mill = 575 points

No. 4 Mill = 750 points

While it may seem strange that the setting on No. 10 mill for .093 gauge is 265 points, it may be well to mention that the difference between the two which is 172 points lies in the fact that the mill is down on face to start with, so, naturally there is quite a lot of spring or deflection in the rolls which must first be taken out in coming up, before the faces of the rolls start to part or open. This holds true in the entire line of stands and the fact that the setting of No. 9 mill is less than No. 10 can be explained by the fact that No. 9 carries more draft while No. 10 is merely a leveling pass.

The range between various gauges that was successfully developed for making section changes follows:

From .041″ to .049″ = 12 points up

.049″ to .060″ = 24 points up

.060″ to .076″ = 24 points up

.076″ to .093″ = 20 points up

.093″ to .107″ = 20 points up

.107″ to .137″ = 32 points up

On all sections over .137″ gauge, change No. 10 mill the same number of points that the gauge changes. Also allow one extra point for each 1″ that width changes.

After the change on No. 10 mill is determined, Nos. 5-6-7-8 and 9 mills are drafted on a straight 25% basis, as follows:

Assuming that the change on No. 10 mill is 80 points, the change on Nos. 5-6-7-8 and 9 would be:

No. 10 Mill..... 80 points
No. 9 Mill.....100 points
No. 8 Mill.....120 points
No. 7 Mill.....140 points
No. 6 Mill.....160 points
No. 5 Mill.....180 points

Example 1

From 44¾″ x .059 to 43″ x .093″ =
.060″ to .076″ = 24 points up
.076″ to .093″ = 20 points up

44 points up for change (on No. 10 mill)

Example 2

From 42¾″ x .140″ to 42¾″ x .188″ =
Difference from .140 to .188 = 48 points up for change (on No. 10 Mill).

Example 3

From 36″ x .076″ to 26 5/16″ x .158″ =
.076″ to .107″ = 40 points up
.107″ to .137″ = 32 points up
.137″ to .158″ = 21 points up

93 points up
10 points up for width difference

103 points up for change (on No. 10 Mill).

Example 4

From 46½″ x .095″ to 62″ x .500″
.095″ to .107″ = 18 points up
.107″ to .137″ = 32 points up
.137″ to .500″ = 363 points up

413 points up
— 16 points down for width difference

397 points up

Made change as follows:

No. 10 Mill.....400 points up
No. 9 Mill.....500 points up
No. 8 Mill.....500 points up
No. 7 Mill.....500 points up
No. 6 Mill.....500 points up
No. 5 Mill.....450 points up

This change was made in the above manner on account of light loads and if figured on a straight 25% basis the draft on Nos. 5, 6 and 7 mills would be nil.

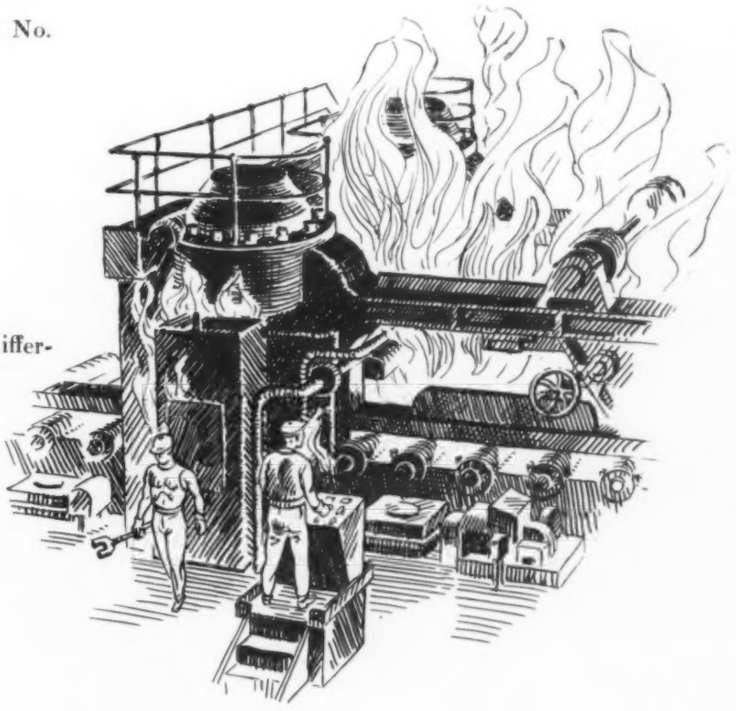
Gauge corrections between the finished strip on the hot bed and mill are made as follows:

On sections under .137 gauge, 1 point up or down by the gauger equals 5 points up or down on No. 9 and 10 mills. All sections over .137 gauge, equal three points up or down on No. 9 and 10 mills. In making gauge corrections of this nature we have the following:

1 point up equals 5 points up on No. 10 Mill
5 points up on No. 9 Mill
2 points up equals 5 points up on No. 10 Mill
5 points up on No. 9 Mill
5 points up on No. 8 Mill
3 points up equals 5 points up on No. 10 Mill
5 points up on No. 9 Mill
5 points up on No. 8 Mill
5 points up on No. 7 Mill
4 points up equals 5 points up on No. 10 Mill
5 points up on No. 9 Mill
5 points up on No. 8 Mill
5 points up on No. 7 Mill
5 points up on No. 6 Mill
5 points up equals 5 points up on No. 10 Mill
5 points up on No. 9 Mill
5 points up on No. 8 Mill
5 points up on No. 7 Mill
5 points up on No. 6 Mill
5 points up on No. 5 Mill
6 points up equals 5 points more on No. 10 Mill,–etc.
5 points more on No. 9 Mill,–

In going from ordinary mild steel to a similar section with .20 or .30 carbon, 5 extra points for each 10 points of carbon are required on No. 10 mill to make the gauge.

While this additional draft does not always hold true it is close enough for the first piece rolled on the section



and any other gauge correction can easily be made on the next strip rolled.

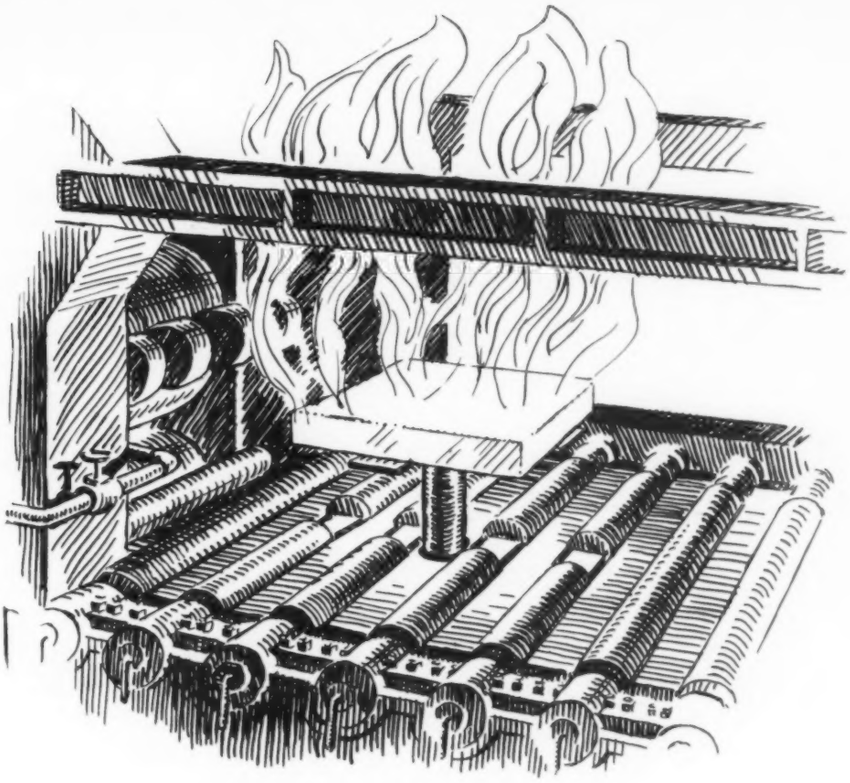
The following table gives the actual loads and motor speeds on the sections designated:

Loads and delivery speeds of various sections.

	No. 5 Mill	No. 6 Mill	No. 7 Mill	No. 8 Mill	No. 9 Mill	No. 10 Mill
.041″ x 25½″	3100	2900	3100	2500	2200	1200 Loads (amp's.)
	210	170	300	325	330	330 R.P.M. (motor)
.049″ x 35″	4100	4000	4300	4000	1600	1300 Loads
	200	260	280	320	330	330
.049″ x 39 13/16″	4500	4600	4800	4600	3000	1300 Loads
	190	245	275	315	325	330 R.P.M. (motor)
.049″ x 53½″	5900	5800	5500	5200	3300	2000 Loads
	225	245	285	305	315	315 R.P.M. (motor)
.050″ x 24¼″	2800	2800	2600	2400	1400	1100 Loads
	200	275	300	320	320	330 R.P.M. (motor)
.050″ x 48½″	4800	4600	4400	4600	4600	1400 Loads
	185	215	240	265	295	315 R.P.M. (motor)
.061″ x 39¾″	3800	3800	3400	4300	2000	1500 Loads
	200	240	255	300	305	315 R.P.M. (motor)
.065″ x 30⅝″	3600	1900	2800	3400	2200	1500 Loads
	250	230	260	280	280	300 R.P.M. (motor)
.074″ x 25½″	2500	2500	3000	3000	2500	1200 Loads
	240	270	275	315	325	330 R.P.M. (loads)
.077″ x 48¾″	5000	4500	4500	3500	2500	2000 Loads
	210	235	250	290	290	315 R.P.M. (motor)
.080″ x 41½″	3700	3800	3800	3700	3200	1500 Loads
	230	240	260	285	285	305 R.P.M. (motor)
.093″ x 43½″	4000	4000	3500	3000	2400	1500 Loads
	235	240	250	265	250	250 R.P.M. (motor)
.093″ x 55½″	5200	5300	4700	4100	3000	1700 Loads
	250	240	260	280	270	280 R.P.M. (motor)
.093″ x 67″	6200	5800	6000	5000	4000	3000 Loads
	250	225	250	260	255	280 R.P.M. (motor)
.093″ x 70½″	7000	7000	6800	6000	5200	2300 Loads
	225	235	250	260	250	270 R.P.M. (motor)
.109″ x 61¼″	5400	5400	5200	3000	2500	700 Loads
	275	260	270	280	265	270 R.P.M. (motor)
.109″ x 42¼″	3800	3800	3500	3000	2500	1700 Loads
	275	275	285	290	270	280 R.P.M. (motor)
.120″ x 44″	4000	2700	2400	2400	2600	1200 Loads
	270	255	250	250	250	250 R.P.M. (motor)
.125″ x 43⅝″	2800	2400	2500	2500	2400	1200 Loads
	240	225	220	230	230	230 R.P.M. (motor)
.138″ x 48¾″	3000	3600	3400	4000	2000	1500 Loads
	250	245	240	260	250	265 R.P.M. (motor)
.138″ x 61″	4600	4500	4500	4400	2800	1100 Loads
	265	240	245	265	255	255 R.P.M. (motor)
.140″ x 40¾″	3000	2700	3000	3000	2000	1500 Loads
	310	280	270	290	270	285 R.P.M. (motor)
.156″ x 38″	2600	3100	3300	2400	2000	600 Loads
	345	300	295	295	280	275 R.P.M. (motor)
.171″ x 34¼″	2500	2700	2600	2600	1900	1000 Loads
	345	300	390	300	275	285 R.P.M. (motor)
.187″ x 34¼″	2400	2400	2200	2500	1600	1300 Loads
	340	290	280	290	260	270 R.P.M. (motor)
.218″ x 34″	1600	2000	2000	2400	1600	1300 Loads
	320	265	250	250	230	240 R.P.M.

Delivery Speed of various sections out of No. 10 Mill.

Section	Motor Speed	Roll Speed	Ft. per Min.
.041 x 21½″	300	192.6	1238
.049″ x 28″	335	201.7	1302
.049″ x 32″	340	204.7	1312
.049″ x 25½″	310	186.6	1200
.049″ x 36½″	340	204.7	1312
.049″ x 38⅛″	335	201.7	1300
.050″ x 33½″	330	198.7	1280
.050″ x 42¼″	335	201.7	1300
.059″ x 41½″	310	186.6	1200
.061″ x 42½″	325	195.6	1258
.063″ x 24½″	325	195.6	1258
.063″ x 31½″	340	204.7	1312
.063″ x 36″	320	192.6	1238
.065″ x 35½″	340	204.7	1312
.070″ x 44½″	300	180.6	1160
.070″ x 20⅜″	275	166.5	1061
.070″ x 25½″	295	177.6	1140
.074″ x 31½″	300	180.6	1160
.074″ x 31¾″	280	168.6	1080
.078″ x 37⅛″	320	192.6	1238
.078″ x 43″	330	198.7	1280
.078″ x 45¼″	310	186.6	1200
.080″ x 43½″	250	150.5	967
.093″ x 59½″	265	159.5	1020
.093″ x 63½″	230	138.5	890
.093″ x 64½″	260	156.5	1000
.093″ x 35″	290	174.6	1120
.093″ x 46¾″	265	159.5	1020
.093″ x 68″	275	165.5	1061
.093″ x 68½″	295	177.6	1140
.093″ x 71½″	275	165.	1061
.095″ x 37¼″	280	168.6	1080
.095″ x 40½″	275	165.5	1061
.095″ x 70½″	270	162.5	1081
.100″ x 37½″	265	159.5	1020
.100″ x 40½″	260	156.	1000
.100″ x 43½″	280	168.6	1080
.100″ x 48½″	265	159.5	1020
.107″ x 62″	260	156.5	1000
.109″ x 32¾″	270	162.5	1041
.109″ x 42½″	245	147.5	948
.109″ x 42½″	285	171.6	1100
.109″ x 62½″	255	153.5	983
.120″ x 44″	250	150.5	967
.123″ x 30⅝″	275	165.5	1061
.125″ x 24¼″	260	156.5	1000
.125″ x 32″	285	171.6	1100
.125″ x 43¼″	275	165.5	1061
.125″ x 43⅝″	265	159.5	1020
.125″ x 56¾″	255	153.5	983
.138″ x 35″	275	165.5	1061
.138″ x 61″	260	156.5	1000
.140″ x 40¾″	285	171.6	1100
.141″ x 70⅜″	255	153.5	983
.156″ x 24⅜″	260	156.5	1000
.156″ x 38″	275	165.5	1046
.156″ x 40″	250	150.5	967
.172″ x 25½″	270	162.5	1041
.187″ x 31½″	265	159.5	1020
.187″ x 39⅛″	250	150.5	967



.218″ x 33½″	245	147.5	948
.250″ x 29¾″	220	132.4	850
.266″ x 40⅛″	240	144.5	930
.065″ x 29⅛″	330	198.7	1280
.049″ x 29½″	340	204.7	1312
.074″ x 27⅞″	310	186.6	1200
.065″ x 31″	350	210.8	1352
.049″ x 35½″	340	204.7	1312

Loads and speeds on High Steel. This is a grade of high strength corrosion resistant, low alloy steel and requires a good mill for rolling as can readily be seen from the loads required.

	No. 5 Mill	No. 6 Mill	No. 7 Mill	No. 8 Mill	No. 9 Mill	No. 10 Mill
74½″ x .188″						
Amps.	4800	6400	5900	4800	2800	2200
R.P.M.	240	295	290	265	260	255
61⅛″ x .077″						
Amps.	7500	7500	5500	3900	3700	1700
R.P.M.	290	300	300	325	330	315
53 ″ x .077″						
Amps.	6500	6500	5000	3800	3500	1700
R.P.M.	295	310	300	230	325	310

The following table gives the actual and theoretical set up on a section of 40½″ x .095″.

Theoretical

	No. 4 Mill	No. 5 Mill	No. 6 Mill	No. 7 Mill	No. 8 Mill	No. 9 Mill	No. 10 Mill
Gauge	750	.400	.300	.225	169	.127	.095
% Draft		47%	25%	25%	25%	25%	25%
Roll Speed R.P.M.		42.9	57.2	76.1	101.5	135	180.6
Motor Speed R.P.M.		270	230	225	230	260	300

Actual

	No. 4 Mill	No. 5 Mill	No. 6 Mill	No. 7 Mill	No. 8 Mill	No. 9 Mill	No. 10 Mill
Gauge	730	.422	.257	.186	.133	.111	.093
% Draft		42%	39%	28%	28%	17%	16%
Load		3000	3000	3200	3200	2400	1200
Roll Speed R.P.M.		35.8	58.7	81.4	113.6	136.2	162.5
Motor Speed R.P.M.		225	235	240	260	260	270
Mill Setting		.575″	.410″	.325″	.350″	.225″	.270″

The draft on plate 53″ wide x .468 Gauge from No. 1 to 10 mills inclusive is as follows:

Slab Size 40 x 4½ x 74—3750 lbs.

4.5″ from Furnace

3.21″ from No. 1 Mill.....28.6% Draft

2.5″	from No. 2 Mill	22.1%	Draft
2.0″	from No. 3 Mill	20%	Draft
1.3″	from No. 4 Mill	35%	Draft
1.0″	from No. 5 Mill	23%	Draft
.82″	from No. 6 Mill	18%	Draft
.68″	from No. 7 Mill	17%	Draft
.58″	from No. 8 Mill	14.7%	Draft
.500″	from No. 9 Mill	13.8%	Draft
.465″	from No. 10 Mill	7%	Draft

In rolling of 18 gauge material extreme caution should be taken in making out the schedule, as well as having the mill in the very best possible condition in regards to newly ground work and back up rolls.

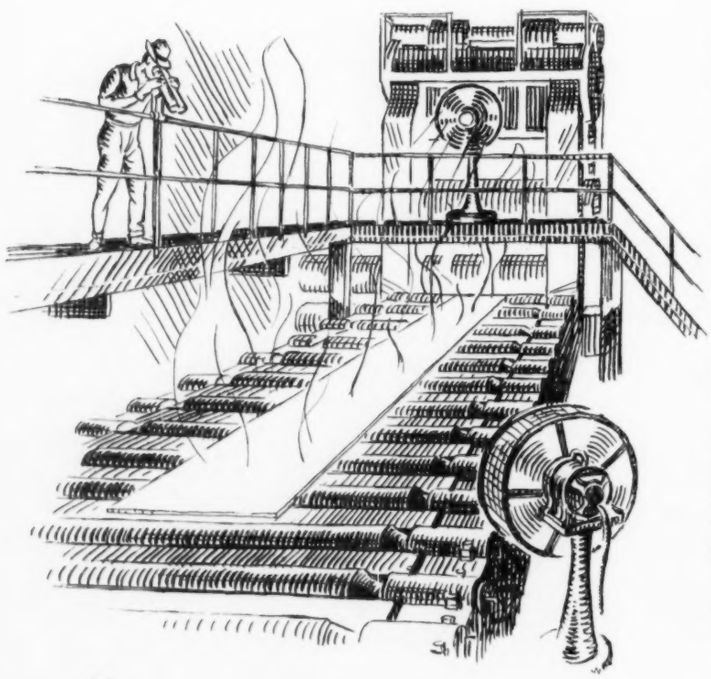
A schedule used in going out to 18 Gage with good success follows. The entire mill should be new with the largest possible size work rolls in the finishing train.

5—34½″ x .095″ coils, 35″ x 5″ —slabs, 4700 lbs.
5—37¼″ x .095″ coils, 37″ x 5″ —slabs, 4700 lbs.
10—40½″ x .095″ coils, 41″ x 5″ —slabs, 4700 lbs.
7—43½″ x .102″ coils, 40″ x 4″ —slabs, 3520 lbs.
15—49½″ x .093″ coils, 40″ x 4½″—slabs, 4450 lbs.
4—48″ x .061″ coils, 40″ x 4½″—slabs, 4450 lbs.
14—48½″ x .049″ coils, 36½″ x 4″ —slabs, 3520 lbs.

Speed changes are made as follows, and this table was worked out in a similar manner as the table covering the draft between various gages.

Mill Change	Speed Change	
No. 10—40 points up	10 Rev. down	
No. 9—50 points up	10 Rev. down	
No. 8—60 points up	8 Rev. down	
No. 7—70 points up	0 No change	See change
No. 6—80 points up	10 Rev. up	as noted in
No. 5—90 points up	25 Rev. up	following:*

No. 5 and 6 mill speeds change in same direction that setting changes.



No. 7 mill speed, changes in opposite direction that setting changes, when making big gauge changes and due to a heavier bar out of No. 4 mill, plus a lighter draft on No. 5 and No. 6 mill—in other words, No. 7 mill is slowed down or speeded up in accordance to the gauge change on the mill. This change of speed is also figured on No. 5 and 6 mill and is either added or subtracted from the regular change whatever the case may be. See details on following mill and speed change schedule.*

Nos. 8, 9 and 10 mill speeds change in the opposite direction that the mill setting changes. The setting on No. 4 mill is practically the same on gauges up to .188″, and changes in accordance with the gauge above .188.

There are 3 ways of making speed changes, as follows:

No. 2 Scale Breaker	No. 5 Mill	No. 6 Mill	No. 7 Mill	No. 8 Mill	No. 9 Mill	No. 10 Mill	
No. 1, Regular change—40 up	25 up	10 up	0	8D	10D	10D	R.P.M. up or Down
No. 2, No. 5 end change—40 up	40 up	20 up	0	0	0	0	
No. 3, No. 10 end change—20 up	0	20D	40D	40D	40D	40D	

The regular change can be used with slight exception at all times and on any section change if heat is not an important factor. Gauge changes between .140″ and .062″ provided they are not over 60 points in gauge can be changed by regular method with satisfaction.

The No. 5 end change can be used at any time, provided the change is not too great. It can readily be seen that on large changes it is not practical to use a No. 5 or a No. 10 end change, but to revert to the regular change.

The No. 5 end change becomes necessary when rolling a section at top delivery speed of No. 10 mill and the section coming up is lighter and requiring specific heat as from .062″ to .049″. Knowing it would be necessary to speed up No. 10 mill, which is impossible as we are already delivering a heavier section at top speed it becomes imperative to make the change on No. 5 end.

The No. 10 end change can be used, when the mill change is not too great and the delivery speed is anywhere from 1100 to 1300 feet per minute, etc.

It is used when on a section that specifies, say 1510° heat when the next section coming up has a maximum heat limit. Thus by putting the change on No. 10 end it is possible to diminish the delivery speed on No. 10 mill and to deliver this section within its heat specification.

The No. 5 and 10 end changes are used for temperature requirements.

On a 120 point mill change, the speed change triples

as follows: 120 ÷ 40 = 3, thus regular change is shown as follows:

Mill No.	Scale Breaker No. 2	No. 5 Mill	No. 6 Mill	No. 7 Mill	No. 8 Mill	No. 9 Mill	No. 10 Mill
Reg. 40							
Point change = 40....	25	10	0	8	10	10 R.P.M.	
Speed change will be 120.	75	30	10	24	30	30 R.P.M.	

Following is a list of mill changes with corresponding speed changes on various sections.

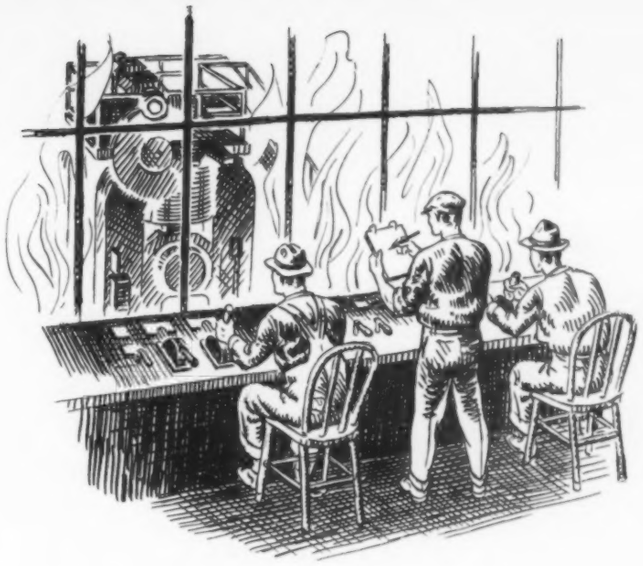
		No. 5	No. 6	No. 7	No. 8	No. 9	No. 10
44½″ x .093″ to 47¼″ x .080″	mill change	45D	40D	35D	30D	25D	20D
	speed change	12D	5D	0	40u	8u	8u
47¼″ x .080″ to 47½″ x .100″	mill change	54u	48u	42u	36u	30u	24u
	speed change	15u	6u	0	4D	6D	6D
47¼″ x .100″ to 52½″ x .095″	mill change	27D	24D	21D	18D	15D	12D
	speed change	8D	4D	0	2u	5u	5u
52½″ x .095″ to 64¾″ x .093″	mill change	36D	32D	28D	24D	20D	16D
	speed change	10D	5D	0	4u	5u	5u
64¾″ x .093″ to 72½″ x .171″	mill change	180u	160u	140u	120u	100u	80u
	speed change	45u	15u	5D	16D	20D	20D
72½″ x .171″ to 74½″ x .160″	mill change	5D	5D	5D	5D	5D	5D
	speed change	Same	as abo	ve (No	chang	e)	
74½″ x .169″ to 74″ x .138″	mill change	75D	65D	56D	48D	40D	32D
	speed change	20D	8D	0	6u	8u	8u
74″ x .138″ to 74″ x .125″	mill change	45D	40D	35D	30D	25D	20D
	speed change	12D	5D	0	4u	5u	5u
74″ x .123″ to 69½″ x .093″	mill change	75D	65D	56D	48D	40D	32D
	speed change	20D	8D	0	6u	10u	10u
69½″ x .093″ to 68″ x .093″	mill change	No ch	ange				
	speed change	No ch	ange				
68″ x .093″ to 44½″ x .093″	mill change	65u	56u	49u	42u	35u	28u
	speed change	No sp	eed ch	ange O	-C Big	width	change
44½″ x .093″ to 61″ x .138″	mill change	75u	65u	56u	48u	40u	32u
	speed change	25u	10u	0	8D	10D	10D
61″ x .138″ to 61″ x .169″	mill change	75u	65u	56u	48u	40u	32u
	speed change	20u	8u	0	6D	8D	8D
61″ x .169″ to 59¾″ x .250″ *	mill change	189u	168u	147u	126u	105u	84u
	speed change	40u	12u	8D	16D	20D	20D
59¾″ x .250″ to 57″ x .250″	mill change	5u	5u	5u	5u	5u	5u
	speed change	Same	as abo	ve—	chang	e	
57″ x .250″ to 50″ x .125″ *	mill change	270D	240D	210D	180D	150D	120D
	speed change	65D	20D	10u	24u	30u	30u
50″ x .123″ to 40″ x .100″	mill change	45D	40D	35D	30D	25D	20D
	speed change	12D	5D	0	3u	6u	6u
40″ x .100″ to 35″ x .137″	mill change	99u	88u	77u	66u	55u	44u
	speed change	30u	12u	0	8D	12D	12D
35″ x .137″ to 35″ x .250″ *	mill change	261u	232u	203u	174u	145u	116u
	speed change	*65u	20u	10D	24D	30D	30D

*These speeds are changed unethically, due to a heavier bar out of No. 4 mill. No. 7 mill is slowed down or speeded up in accordance to the gauge change on mill. This change of speed is also figured on No. 5 and No. 6 mills. No changes are made on No. 4 mill up to .188 gage.

u { up
D { down

Providing

From the foregoing, it is very obvious that proper lining up of the mill is essential in eliminating unnecessary roll changes, broken rolls and retarded operation which may result from improper charging of steel. The provider should be thoroughly familiar with all entry clearances and mill drafts as well as what the furnaces and the mill itself is capable of producing.



General roll changes should be eliminated as much as possible and as far as delivery of material will permit. Whenever it is possible, all of the widest and hardest sections to produce, should be rolled the first part of the week. If the mill is lined up properly, one general roll change every 24 hours should be sufficient.

Sections that have been produced very successfully on the mill we are discussing, are as follows:

11 Gauge	73	x .123
12 Gauge	73	x .107
14 Gauge	67½	x .076
15 Gauge	62	x .069
16 Gauge	61	x .061
18 Gauge	54	x .049

In rolling any of the above sections all of the mill rolls must be in the very best possible condition.

In making out a schedule for going out to a wide section, after a general roll change consisting of No. 2 to 10 mills, inclusive, the following lineup has proven very satisfactory.

No. of Pieces	Section	Slab Size	Slab Weight
6	35⅛″ x .109″ coils	37″ x 5″	4700 pounds
11	40½″ x .093″ coils	41½″ x 5″	3500 pounds
10	46″ x .093″ coils	40″ x 4½″	4500 pounds
10	55¼″ x .093″ coils	41½″ x 5″	4700 pounds
6	61″ x .138″ flats	41″ x 5″	4700 pounds
2	67″ x .138″ flats	41″ x 5″	4700 pounds
3	70½″ x .138″ flats	41″ x 5″	4700 pounds
10	73″ x .107″ flats	41½″ x 5″	4700 pounds
180	70½″ x .095″ coils	41½″ x 5″	4700 pounds

A question which arises frequently in regards to going out to a wide section after rolling a number of narrow sections without changing any rolls, is answered by the following schedule which was noted in actual rolling practice, however, most of the sections were of a heavy gauge which was largely responsible for this performance.

No rolls were changed in carrying out this line up.

No. of Pieces	Section	
8	74½″ x .250″	
2	70½″ x .250″	
2	70½″ x .250″	
3	74½″ x .500″	17 car
2	62½″ x .250″	17 car
6	62″ x .250″	
2	50 ″ x .250″	17 car
8	46½″ x .250″	16 car
14	38½″ x .250″	16 car
5	37 ″ x .250″	17 car
28	34½″ x .325″	20 car
12	31½″ x .375″	13 car
4	27 ″ x .375″	16 car
2	32¾″ x .093″	560 tons to here
2	33½″ x .093″	
5	40¼″ x .093″	
7	44¾″ x .093″	
4	53″ x .093″	
1	59½″ x .091″	
5	63″ x .095″	
5	67½″ x .093″	
13	72½″ x .093″	Etc., Etc.

In starting up the mill after a general roll change the first section should be full cold roll coils rather than flat rolled material. The first few pieces may be off gauge and as the gauge in full cold rolled coils is reduced further an off gauge section or two will not make any difference, whereas if rolled into flats they may be rejected.

The shrinkage in gauge of the cold product as compared to the gauge when hot is negligible and can be disregarded entirely, however, this does not hold true in the width and length. The shrinkage in width is approximately ⅛″ per foot on practically any section, so in rolling a section 36″ wide, rolled edge in which the tolerance is ¼″ over and "O" under, the roller would aim at 36⅝″ wide, which when cold would measure from 36⅜″ to 36¼″ wide.

In the rolling of flat material such as plate which calls for a given number of cuts at a given length and which are cut hot, the slab provided should carry enough weight to allow 8″ extra length for each piece. These figures are based on the rolling of strip of .250″ gauge from which 4 pieces, 480″ long each were cut and is ample allowance for any similar section. In providing maximum weight slabs for any coiled section some consideration should be given to the possible telescoping at the coilers.

Normally good coils are produced by running the coiler about 100 ft. per minute faster than the delivery speed of No. 10 mill, and keeping the strip tight between mill and the coiler. Any looping or lapping of the strip on hot bed is sure to result in a telescoped coil, particularly on the lighter gauges. On a section of 55″ x .080″ which was coiled hot, and using a slab of 7000 pounds, telescoping was very pronounced. By cutting the slab weight to 5000 pounds a perfect coil was produced. The above sections were coiled on coilers that were equipped with air operated side entry guides.

Yields for various commodities on rolled strip are as follows:

95% on coils
87% on plate
90% on flat rolled material (92% on roll edge)

Shearing allowances are as follows:

Straightway rolling

Flats up to 41″ wide	⅝″
Flats strip over 41″ wide	1″
Plate 41″ wide	2″

Cross rolling

Up to 53″ wide	¾″ on Flats
Up to 72″ wide	1″ on Flats
Up to 70″ wide	2″ on Plate
Up to 72″ wide	2½″ on Plate

Slab sizes for various sections are as follows: All 16 gauge flats .061 to 39″ wide are rolled from 3″ slabs. All 14 gauge flats .077 to 39″ wide are rolled from 3½″ slabs. 12 gauge—.109″ and heavier 4″ slabs. All over 10 gauge—5″ slabs.

Cross rolling 53″ to 72″ wide—41″ x 5″ slabs 67″ to—87½″ long.

40″ x 4⅜″ slabs—for 47″ up to 70″ wide
40″ x 4½″ slabs—for 45″ up to 70″ wide
40″ x 4″ slabs—for 42″ up to 60″ wide
36½″ x 4″ slabs—for 42″ up to 53″ wide

Flats	Slabs
16 Gauge—42″ wide	30½″ x 4″ slabs 2350 lbs.
16 Gauge—48″ wide	34″ x 4″ slabs 2700 lbs.
16 Gauge—60″ wide	40″ x 4″ slabs 3200 lbs.

While most of the principal, and practical problems in hot strip rolling have been described it was not the writers intention to cover the complete operation and all of the inherent details of the mill. Many an interesting article which would include processing and finishing can yet be written on the subject.

GAS DISTRIBUTION

At River Rouge Plant, Ford Motor Co.

By F. J. HARLOW, Manager
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DETROIT, MICHIGAN

Presented before the Annual Convention of the A. I. & S. E., Detroit, Michigan, Sept. 22-25, 1936

▲ MANY articles have been written about the magnitude of the Ford Motor Company's 1096 acre Rouge plant—its 7¼ million square feet of floor space—its daily water requirements of 538 million gallons (which is more than required to serve the cities of Detroit, Cincinnati and Washington combined)—its power consumption and other requirements of this Gargantuan organization.

Stories have been written about the huge blast furnaces with a capacity of 1600 tons of iron, and how a unique dustless cement plant makes 2600 barrels of cement per day from the blast furnace slag.

But words cannot give an adequate picture of this industrial giant. It must be seen to be appreciated and when you do see it, it won't be hard for you to understand why 5000 men wear out 3000 brooms, 5000 mops, and use 172,000 pounds of soap each month to maintain the high housekeeping standards evident on every hand at Rouge plant.

F. J. HARLOW

But even after you've seen the physical structures, the machinery, the furnaces and the thousands upon thousands of employees, you will still probably have difficulty in grasping the magnitude of one prime necessity in the operation of that huge plant—heat.

Just as sunshine is necessary to a farmer, so is heat necessary to most industrial plants—and like sunshine, heat is often taken for granted, especially in plants where a city distribution system or a central plant furnishes heat and power.

It is not the purpose of this paper to encompass the entire heating problem at Ford Rouge plant, but to give you an outline of one branch of the problem—the gas distribution system—and to explain how the equivalent gas is produced, purchased, mixed and controlled each working day. And if you can't quite grasp 90,352,000 cubic feet of gas, just think of it as more than enough city gas to supply 1,020,000 average American families or 4,794,000 individuals (at 4.7 persons per family). That's 11.5% more gas than has ever been used by all the city of Detroit, including 671 industrial plants, and including 12 suburban towns, on the biggest peak consumption day in 1934.

Gas is heat. Therefore as heat properly applied is responsible for the many service characteristics of the parts incorporated in the modern automobile—gas production and distribution is one of the major problems at Rouge plant.

If this demand for heat at the Rouge plant were as constant as it is with the utility supplying gas to a municipality the problem would be comparatively simple.

The demand for gas not only varies with the production of cars but the supply also varies with the coke requirements of the blast furnace and foundry and the seasonal consumption of domestic coke which is also a product of the coke oven plant, all of which tends to complicate the problem of gas distribution.

The engineers spend considerable time and study on the respective inherent characteristics of the various fuels in order to allot the proper heating medium to each production operation so as to maintain the quality desired in each part.

Mr. Average Citizen invariably spends considerable time and study on the relative merits of the various makes of automobiles before making a choice. However, when his selection is made, he comes into the market with an insistent demand for the desired car immediately.

This buying tendency, coupled with a desire to own the latest model, has created very high peaks in production in the automobile manufacturing industry.

Therefore, as heat is such an important tool of production, various types of fuel must be available. Each

must be properly applied, in order to produce the quality desired in each part to maintain the high standards required at all times.

In the modern automobile plant, many types of fuel can be and are used; as,

(1) Coal for boiler fuel to produce power in the form of electricity and compressed air, and also for steam to heat shops and offices and for the operation of washers, dryers and plating tanks.

(2) Electricity for use as a furnace fuel for heat-treating and as an electric furnace smelting fuel.

(3) Oil for forging, normalizing, drawing and other heat-treating operations where scaling is not objectionable. Oil is also frequently used as boiler fuel.

(4) Tar for use much the same as oil.

(5) Gas is used as high form fuel for quality heat-treating under close control, for both atmosphere and temperature. Gas is frequently used as an atmosphere in certain furnaces where electricity is used as the heating medium. Gas is coming into universal use for japan, lacquer and paint drying ovens of the direct fired type.

Gas, because of its form value, is used for glass melting, firing stoves on blast furnaces, under-firing coke ovens and direct heating of air for space heating and "make-up" air for spray booths.

Ford Motor Company utilizes all of the above fuels at Rouge.

At Ford Motor Company's main plant at River Rouge, this problem of heat supply is of far greater importance than in most automobile plants, the reason for this being that a great deal of material such as steel, glass and other basic materials are produced. The Steel Mill and Glass Plant each require large quantities of fuel for their operation alone. The quantities of the various fuels consumed at the Rouge plant per average day are as follows:

Coal—Boiler House	2,000 tons per day
Coal—Coke Ovens	3,000 tons per day
Oil—Forge and Steel Mill	80,000 gallons per day
Coal Tar	40,000 gallons per day
500 B.t.u. Coke Oven Gas	54,000,000 cu. ft. per day
100 B.t.u. Blast Furnace Gas	564,480,000 cu. ft. per day
3200 B.t.u. Liquefied Petroleum Gas, (Butane)	640,000 cu. ft. per day

However, as the gas is produced from the coal used at the coke ovens, the coke oven coal consumption can be neglected in the total.

This paper is to discuss the gas distribution and requirements for regular production, therefore, it might be well to pause and consider the gases required as a single gas. For this interesting comparison, let us choose the 500 B.t.u. coke oven gas, as this most nearly conforms to the usual public utility standard manufactured gas of 530 B.t.u.

500 B.t.u. Coke Oven Gas	54,000,000 cu. ft.
3200 B.t.u. Butane at 500 B.t.u.	4,096,000 cu. ft.
100 B.t.u. Blast Furnace Gas at 500 B.t.u.	32,256,000 cu. ft.
Total gas required at 500 B.t.u.	90,352,000 cu. ft.

To store and maintain continuity of service at Detroit, a storage holder capacity of approximately 58,000,000 cubic feet of gas is provided. The gas storage capacity at River Rouge when completed will consist of:

Main Gas Holder	Capacity 10,000,000 cu. ft.
Liquefied Petroleum Gas Tanks equivalent Coke Oven Gas	Capacity 50,000,000 cu. ft.
Process Holder	Capacity 200,000 cu. ft.
TOTAL	60,200,000 cu. ft.

The facilities provided to meet this enormous demand for gas in the various departments are very elaborate. The distribution of gas at Rouge is handled on a very different basis than that of the public utility.

The public utility furnishes gas to its customers within very definite thermal value limitations imposed by franchise specifications, usually under State Public Service Commission control.

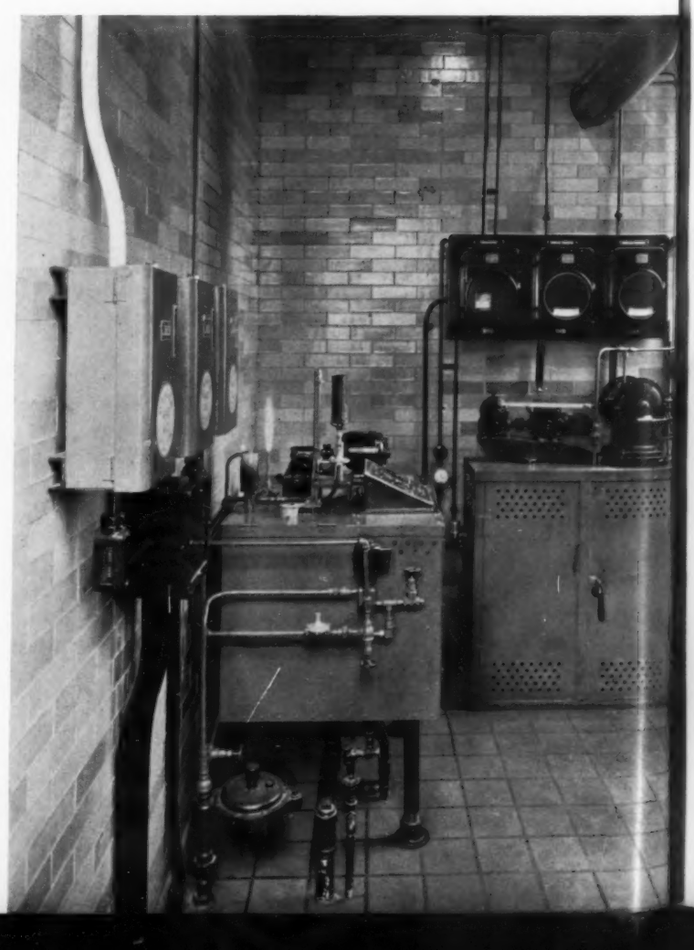
However, at River Rouge the gas is served to the plant in general, based on constant combustion characteristics, rather than on thermal value. To accomplish this a 500 B.t.u. coke oven gas is taken as a standard base gas.

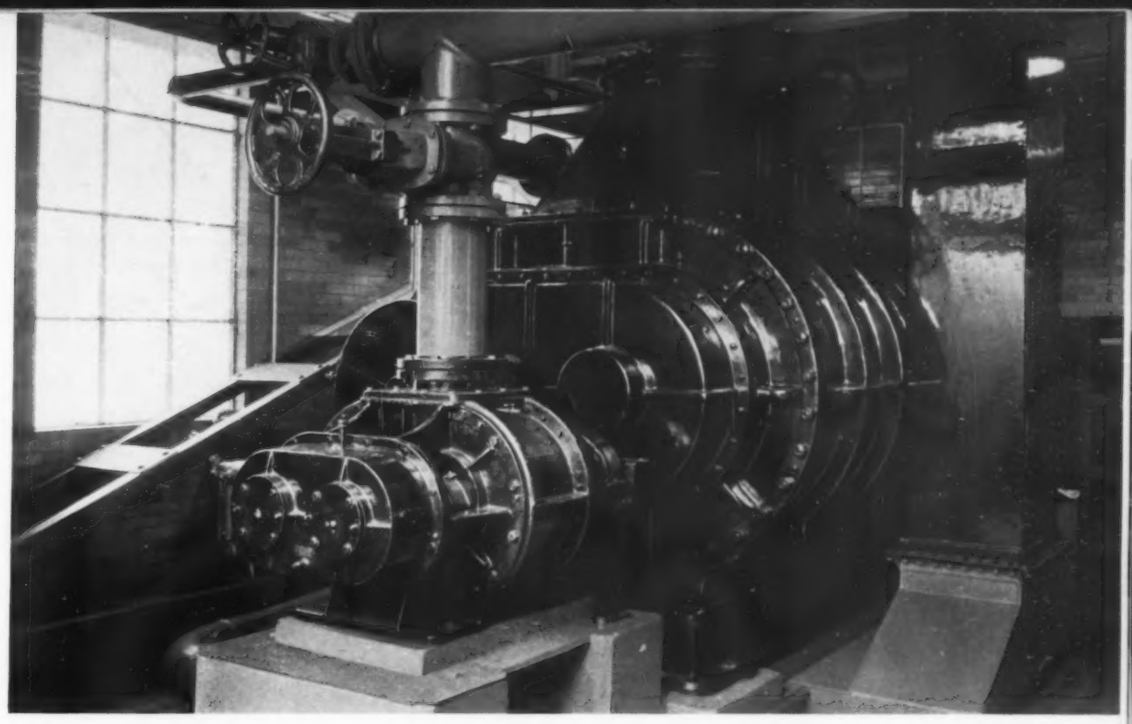
The other available gases are blended to augment this coke oven gas supply, based wholly on the ability of the blend to function interchangeably with this base gas in any given appliance, with coke oven gas efficiency at a constant distribution line pressure.

The distribution and allotment of the various fuels based on current availability is under control of the Coke Oven Department.

This control is maintained by a gas dispatcher who keeps a continuous check upon send-out and distributes the available gas to the various demands in sequence of their importance.

Calormixer room showing mix control installation.





This is the propane blast furnace gas mixing station. The small positive blower is chain drive connected to the large blower. Propane at 10 lb. + operates as an engine boosting blast furnace to 20″H_2O from about 4″H_2O. The two gases then mix under calorizer control.

In the control room of the blast furnace gas booster station there is an instrument panel upon which are mounted flow meters, tachometers, low level indicators for holders, pressure gauges, etc. In front of this instrument panel at a desk the gas dispatcher operates control keys, signal lights and push buttons all of which are mounted flush on the desk top. These devices are arranged in units. A typical unit consists of four colored lights, a signal key, a control key, a telephone and a push button on a rectangular plate. Corresponding equipment is located at each remote point where control is necessary. There is also remote control valves, motor-close, manual-open, which are handled by dispatcher. The dispatcher also has remote control circuits for all booster pumps and fans.

The general scheme of operation is as follows:

1—Dispatcher operates signal switch which lights indicating lamp at his central control station and sounds horn, and lights signal light at remote station.

2—Operator at the remote station operates the switch which stops the horn and puts out the signal lights at his station and at dispatcher's station, thus indicating to the dispatcher that his call has been received.

3—Dispatcher may operate telephone key connecting him with remote station.

4—Or dispatcher operates control switch to close valve which lights amber light at his control station and a signal light at a remote point. The valve closes and the opening circuit is broken, lights at both points remain on to indicate valve is locked.

5—Dispatcher can also unlock valve with reset button which puts out lights and re-establishes the circuit allowing valve to be opened.

6—Dispatcher can also operate signal if he desires to communicate with any remote station operator.

These are located about the plant at strategic points as follows:

A—Two remote stations at blast furnace stoves.

B—Four remote stations at boiler house gas mains.

C—Two remote stations on blast furnace gas line to coke ovens.

D—Three remote stations on blast furnace gas line at No. 3 mixing station.

E—One remote station on mixed propane-blast furnace gas line leading into coke oven gas line.

F—One remote station on blast furnace line foundry (Future installation).

G—One remote station on blast furnace gas line to soaking pits.

H—Seven remote stations on coke oven gas line to re-heating furnace.

I—In addition to these remote stations, provisions are made so that operator may control.

J—Three points to start and stop booster fans.

K—Three points to change speed of each of three booster fans and to change position of louvres.

L—One point to operate damper in 60″ gas main to coke ovens.

M—One point to operate damper in 42″ gas main to foundry—future installation.

With all of the equipment under above control the gas distribution is well in hand.

All in all, many problems in gas distribution have been encountered and the methods of solution are interesting.

In the solution of these problems, safety was always held "First" and all precautions were taken to make the whole system as safe as is possible.

The gas production facilities at Rouge will be composed of the following equipment when the present building program is completed.

COKE OVEN PLANT

The coke oven plant is composed of:

Two Batteries of Wilputte ovens, 60 ovens each. These ovens are 16″ wide, 40′ 4″ long and 12′ 0″ high—capacity approximately 14.2 tons per oven.

One Battery of 60 Semet-Solvay ovens, 19″ wide, 38′ 0″ long and 10′ 9½″ high; capacity approximately 14.2 tons per oven.

Two New Batteries of Koppers ovens now under construction, of 61 ovens each, will be 17½" wide, 40' 3½" long and 13' 3" high.

The existing ovens are heated with coke oven gas. About 45% of the total gas made is used for this purpose.

The new Koppers ovens will use blast furnace gas for underfiring. When the new ovens are completed, the total production of coke will be about 4500 tons per 24 hour day.

The coke oven plant produces both domestic coke and metallurgical coke. The coking cycle for domestic coke is 15 hours and for metallurgical coke 20 hours.

The metallurgical coke is used in the blast furnaces and foundries.

The domestic coke is sized and sold principally for domestic consumption.

The coke breeze from sizing is sent to boilers and burned on chain grates or is ground with the powdered coal and burned in the cement mill and boiler house.

The gas is distributed throughout the plant as process fuel.

The coal charged to the ovens is a mixture of high volatile Kentucky and low volatile West Virginia Pocahantas.

The coal mixing station is located on an extension of the blast furnace overhead line from where it is handled to the various coke ovens.

BOOSTER STATIONS

The present booster station located at the coke oven by-product plant may be discontinued.

The new blast furnace gas booster station is located on the 60" blast furnace line between blast furnaces, boiler house and coke ovens.

This station is equipped with two 30,000 C.F.M. fans with a boosting range of 20" H_2O pressure.

The new coke oven gas booster station will be located at outlet of 10,000,000 cu. ft. holder. This station will be equipped with two 10,000 C.F.M. boosters, outlet pressure 13 pounds, pumping into a 30" main supplying regular production heating operations; and three 10,000 C.F.M. boosters, outlet pressure 2 pounds, pumping into 36" main which supplies open hearths, soaking pits, re-heating furnaces and glass plant.

BY-PRODUCT PLANT

The "gas make" of the coke ovens is about 12,000 cubic feet of 500 B.t.u. gas per ton of coal charged, and is processed in the conventional manner in a modern gas purification and by-product recovery equipment.

The by-product recovery per ton of coal charged approximates:

2½ gallons of light oil—This light oil is blended with straight run gasoline and is sold under the trade name of Ford Benzol.

19 pounds of ammonium sulphate. This is sold as fertilizer and for other purposes.

8½ gallons of coal tar. Some of the tar is sold and the surplus is burned under boilers and at the open hearth plant.

PROPANE BLENDING STATION

The propane blending station consists of six vaporizers, each with a rated capacity of 8000 cubic feet of liquified gas per hour or an approximate total of 50,000 cubic feet per hour of butane which is equivalent to 3,200,000 cubic feet of 500 B.t.u. coke oven gas per hour.

The propane or butane is piped to the vaporizer as a liquid where it is expanded to a vapor under automatic control as the requirements for gas demand. The latent heat of vaporization, which is 830 B.t.u. at 12°F., the initial boiling point for butane, and 785 B.t.u. at 51°F. for propane, is furnished by steam.

The vapor is then reduced in pressure by the use of conventional gas governors to approximately 10 pounds discharge pressure at the outlet of the vaporizer.

This ten pound gas is then fed to a positive blower of the Connersville type rated at 240,000 cubic feet per hour. This blower acts as an engine under the 10 pound gas pressure and pulls the 900,000 cubic feet per hour blower by chain drive, which takes either blast furnace gas from the 60 inch diameter blast furnace gas line or air from the atmosphere and boosts it to 20 inches water pressure. In doing this work, the gas is reduced from 10 pounds to also approximately 20 inches water pressure as the engine blower is acting as a mechanical expander. In this manner the propane gas and air or propane gas and blast furnace gas are mixed in a constant ratio of approximately one to four.

At the discharge of the gas engine blower there is a small shunt line taking undiluted propane from the main line and blending it into the mixture. In this shunt line there is a valve operated by an Askania control which, in turn, is controlled by a Cutler-Hammer Calor-mixer or constant B.t.u. controller. This controller gets its gas sample from a distance down the line far enough to allow good diffusion in the blend but not far enough to cause too great a lag in the control.

It is recognized that there are numerous other systems for blending, however this was selected because of the safety feature. It is impossible to get air into the system without the safe quantity of gas. If the gas supply or pressure fail, the engine blower will not actuate the air blower and the mixing stops.

The storage tanks for gas with a combined capacity of 60,200,000 cubic feet of coke oven gas are provided to maintain continuity of gas service.

(1) One 10,000,000 cubic foot dry type gas holder. This holder is under construction and will be 219 feet in diameter by 350 feet to the crown of the roof.

(2) Six 25,000 gallon propane storage tanks located at the blending station.

(3) Two 25,000 gallon propane storage tanks located at Glass Plant.

(4) One 200,000 cubic foot process gas holder at blending station. This holder is of the wet type.

BLAST FURNACES

There are two blast furnace stacks, each 92′ 0″ high with hearth diameters of 18′ 6″. The bosh diameter is 22′ 3″. The combined annual capacity is about 550,000 tons of pig iron.

Each blast furnace is equipped with four hot blast stoves. These stoves are 110 feet high and 24 feet in diameter and have a heating surface of 137,000 square feet.

The blast furnace gas used for firing the stoves and for plant consumption is passed through dust catchers, primary washers and then through electrical precipitators.

The gas production of the two blast furnaces is 6,720,000 cubic feet per hour.

The blast furnace consumption of the hot stoves is 1,620,000 cubic feet per hour.

The consumption of fuel in the open hearth plant is 150,000 cubic feet of 500 B.t.u. gas per hour or 360 gallons of oil or tar per hour.

Steel Mill

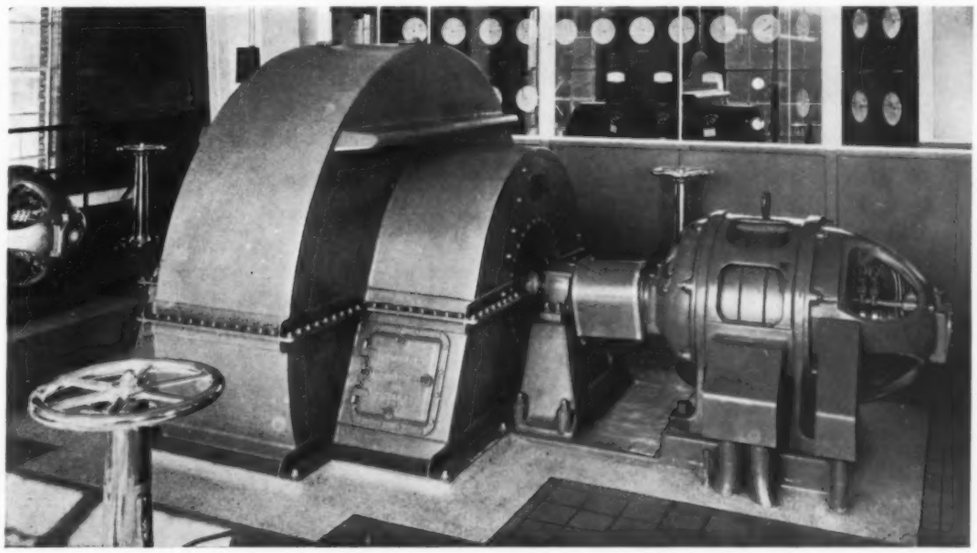
The equipment of the steel mill exclusive of open hearth, such as the hot mill slab and reheat furnaces, are all equipped with combination oil and gas burners. This equipment will burn either gas, oil or tar.

The gas consumption is 540,000 cubic feet of 500 B.t.u. gas per hour.

The oil consumption is 828 gallons of oil or tar per hour.

Soaking Pits

The soaking pits are equipped to use either gas or oil.



Blast Furnace Gas Booster. Gas Dispatcher's Control Panel in rear.

GAS CONSUMPTION BY DEPARTMENTS

The residual blast furnace gas 5,100,000 cubic feet per hour is either blended with propane and/or butane to augment the coke oven gas supply or is sent to the main boiler house to be used as fuel.

The gas consumption by departments is as follows:

Open Hearth

The open hearth plant consists of ten furnaces. Five of these furnaces are stationary and four are tilting type. These furnaces are rated at 100 tons each.

The tenth furnace is a 400 ton tilting furnace.

Three furnaces are fully equipped with combustion control.

The open hearth furnaces are equipped to burn either gas, oil or tar as available.

The waste heat is put through waste heat boilers of the fire tube type and generate steam for power, heating and process work.

Gas requirements are 180,000 cubic feet of 500 B.t.u. gas per hour.

Oil requirements are 207 gallons per hour.

Main Power House

The main power house at Rouge is the largest high pressure, high temperature (900°F.) industrial power plant in the world. It is equipped to burn either coal, gas, oil, or tar. A unique feature is that liquid, solid or gaseous fuels may be consumed under the same unit simultaneously.

The gas fuel requirement of this power plant is 3,600,000 cubic feet of blast furnace gas per hour or 83.3 tons of coal per hour. The oil and tar are only used in case of emergency.

SPRING AND UPSET DEPARTMENT

The spring and upset department furnaces are equipped to burn oil or gas.

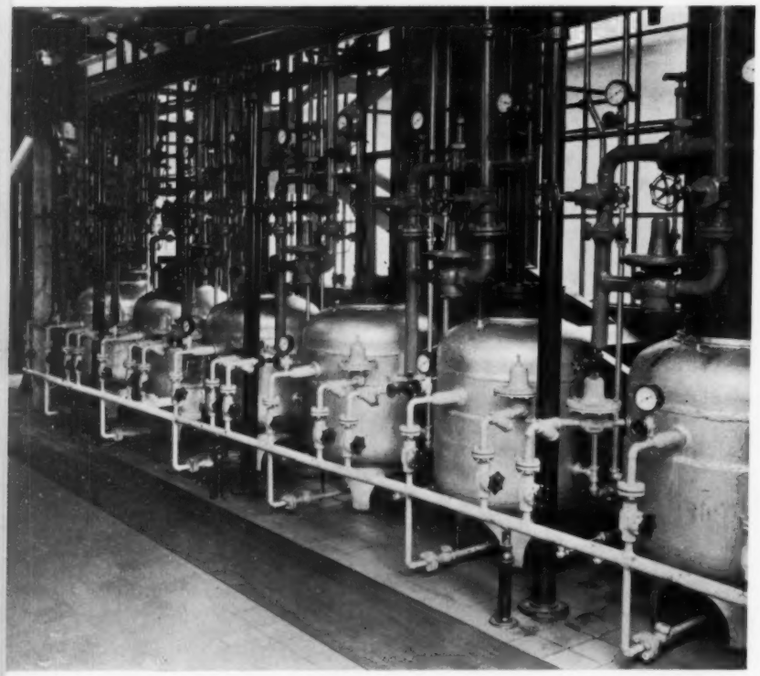
The gas requirement of this department is 480,000 cubic feet of 500 B.t.u. gas per hour.

The oil requirement is 828 gallons per hour.

"B" Building

The "B" building heat treating operations require 120,000 cubic feet of 500 B.t.u. gas per hour.

In the heat treat department in certain controlled atmosphere appliances, such as gas carburizing furnaces, the atmosphere is maintained by the use of liquefied petroleum gas and is here restricted to propane.



These are the propane vaporizers.

Motor Building

In the Motor building the gas consumption is 60,000 cubic feet of 500 B.t.u. gas per hour.

Core Ovens

The foundry core ovens have a demand for gas of 1,320,000 cubic feet of 500 B.t.u. gas per hour.

Glass Plant

The glass plant being rather foreign to the steel industry is probably of sufficient interest to justify a short pause in the gas discussion for a short description of this very large gas consumer.

The capacity of the glass plant is 75 to 100 tons of plate glass per twenty-four hour day.

The continuous process is used and is carried on in a melting furnace, or as is commonly called in the glass industry "tank".

This tank is 22 feet wide by 117 feet long. The "hot" or melting zone is 60 feet long.

Approximately 1000 tons of molten glass in a bath 5 feet deep is carried in the tank when in operation.

The "tank" is of the regenerative type and is fired through six heating ports 2′ 6″ wide by 4′ 0″ in height. A Telechron Clock reverses the fires automatically on a fifteen minute cycle.

It has long been recognized that gas density is also an important function in certain departmental operations. In the Glass Plant the liquefied petroleum gases are used undiluted because these dense, high thermal value gases lend themselves very well to glass melting and planing.

The firing system consists of injecting a layer of air and a layer of fuel gas. The radiant heat from the walls and molten glass cracks the hydro-carbons to carbon and produces a radiant flame.

The furnace is fired with either coke oven gas, propane and butane and it is also equipped so that a blend of these gases may be used.

To control flame length delayed combustion resulting in a luminous flame is used.

The raw materials are mixed automatically under very close control in traveling scale hoppers.

After the mixing is done the batch is briquetted before charging into the tank.

This briquetting not only eliminated the dust but also affected further economies in operation and maintenance. When a 1000 ton tank is charged with a powdered charge approximately 900 pounds of soda ash is volatilized per day, thus this loss has been eliminated. The briquettes are pillow shaped 2″ x 2″ x 1½″. Briquetting, it is said, is also responsible for eighteen months continuous operation with only one hot repair.

A 290 horse power waste heat boiler of the water tube type with three drums has been successfully operated on the outlet of the tank. This boiler is equipped with superheater, economizer and a 6′ 6″ induced draft fan.

The economizer is used to heat about 200 gallons of water per minute. This hot water is used in the laundry.

The steam pressure is 175 pounds with superheat to 525°F.

The heat saving allocated to these waste heat appliances are:

13.5% to the boiler
6.0% to the economizer
7.0% to stack as draft

A temperature check on the tank showed the following heat gradient through the system:

Melting Tank	2600°F.
Refining Tank	2210°F.
Boiler Entrance	1300°F.
Economizer Entrance	625°F.
Economizer Exit	375°F.
Stack Temperature	150°F.

The glass rolls are 78″ wide which includes 10 inches on each end to radiate heat and protect bearings.

The glass ribbon is 46 inches wide and $\frac{3}{16}$ inches thick. The temperature at second pair of rolls is 1150°F. and enters the lehr at 1100°F. The lehr is 400 feet long. The glass is carried through on a belt driven by a 40 horse power motor. Speed of glass

through lehr is 3¼ miles per day. Exit temperature of glass leaving lehr is 150°F.

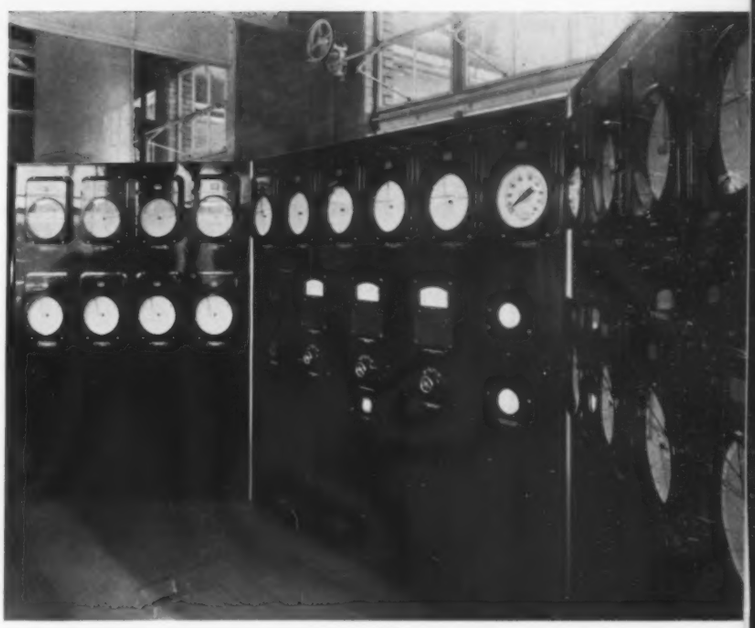
The firing system is rather unique in that when coke oven gas is used to fire the tank some of the products of combustion from the stack are mixed with the fuel gas by means of a suction fan. These stack gases slow down the rate of flame propagation and allow the projection of longer flames.

However, when propane or butane is used the damper at the stack is closed and a bypass valve on the fan intake is opened allowing fresh air to be mixed with the propane or butane to raise the cracking temperature because at the high temperature of the tank these gases if undiluted would crack instantaneously forming carbon and would most likely create a "hot spot" instead of allowing delayed combustion to take place which makes for a longer flame.

Coke oven gas consumption is 120,000 cubic feet of 500 B.t.u. gas per hour.

Butane consumption is 18,600 cubic feet of 3200 B.t.u. gas per hour or 580 gallons per hour.

Propane consumption is 23,650 cubic feet of 2537 B.t.u. gas per hour or 653 gallons per hour.



Gas Dispatcher's Control Panel.

QUALITY CONTROL OF GAS SUPPLY

Formerly the residue blast furnace gas 5,100,000 cubic feet per hour was sent to the boilers and there fired with the powdered coal at coal prices.

As gaseous fuel when clean is a high form fuel, it was decided by Ford engineers to clean this blast furnace gas. The cleaning equipment consists of disintegrater, washers and electric precipitators. The sulphur content of the cleaned blast furnace gas is set at a maximum of .005 grain per cubic foot. In the clean state it could be boosted to line pressure and some of it blended with coke oven gas.

The coke oven gas as produced has a thermal value of approximately 505 B.t.u. per cubic foot. This gas is then reduced to 500 B.t.u. per cubic foot by blending with blast furnace gas or air to maintain a constant thermal value "send out".

It is interesting to note that either air or blast furnace gas can be used interchangeably to blend the coke oven gas from 550 to 500 B.t.u. The reason being that the specific gravity of the blast furnace gas is approximately one (1) and air equals one (1), therefore, very little effect of the resultant mixture gravity is noted.

As there was still an excess of blast furnace gas over and above that required to blend down the coke oven send out, it was decided as this gas would be clean and of too high form value to go to boilers, to install a liquefied petroleum gas blending station to step up the thermal value of the clean gas to a value usable in regular plant production for heat treating over heating, glass plant, etc.

Therefore, the propane and butane storage tanks with sufficient vaporizer facilities were installed to more than handle the residual blast furnace gas.

As the butane and propane both are of very high thermal value in a gaseous state and as the specific gravity of these gases varies nearly in direct proportion with their thermal value, they could be used interchangeably or together for blending with either blast furnace gas or air to augment the coke oven supply as the demand for gas by the plant required.

The thermal value of propane, chemical formula C_3H_8, in its normal state as a gas, is 2537 B.t.u. per cubic foot with a specific gravity of 1.5 while butane, C_4H_{10}, has a thermal value of 3200 B.t.u. and a gravity of 1.95. It will be seen that either propane or butane blended with either air or blast furnace gas with gravity equaling one will be interchangeable or even again blendable with each other, with little change in combustion characteristics for the same resultant thermal values. Even the rate of flame propagation is practically constant for the two blends. This is because the burning speed of carbon monoxide and either propane or butane are nearly the same. Propane and butane have a flame velocity of about one (1) foot per second while that of carbon monoxide is one point three (1.3) feet per second.

There was, however, a problem requiring considerable thought. This was the selection of the proper thermal value in the propane and/or butane and/or blast furnace gas and/or air blends, to be either mixed with to augment, or to replace the coke oven gas "send out".

As the coke oven gas as distributed has a thermal value of 500 B.t.u., a specific gravity of point four seven (.47) and a rate of flame propagation of approximately two point three (2.3) feet per second, it was imperative that these characteristics be compensated for as near as possible in the "standby" gas for efficient appliance operation.

In the solution of this problem, it was extremely fortunate that the resultant thermal value of the blend could be disregarded, which cannot be done where the gas is to be sold by a public utility operated under a public franchise.

It was first necessary to establish the most desirable features of service so as not to effect production. In

efficient industrial equipment operation there are two conditions which must be maintained by the burners; they are heat delivery and maintenance of the desired atmosphere in the furnace at a wide "turn up" and "turn down".

However, in most industrial operations the ideal is hard to attain. Frequently a compromise is necessary; fuel cost, equipment cost, maintenance and operating cost, must be balanced against the lowest allowable cost for the heat treated article of the desired quality. To establish B.t.u. input for a given furnace or other gas burning appliance successfully, consideration must be given, first, to the burner capacity in B.t.u. per unit of time; second, the amount of heat that can be liberated per cubic foot of combustion space by the gas under consideration; third, wall area exposed to the work to be heated as a major portion of the heat comes from this source, and fourth, consideration must be given to the material in and shape of the article to be heated. While it is true that the B.t.u. estimated from these various angles will not check, in a successful furnace the thermal input estimated on these factors should agree reasonably close.

As stated before, it was extremely fortunate that at the Rouge Plant there were no thermal value limitations except those imposed by safety. In other words, the top limit was butane with 3200 B.t.u. per cubic foot and the bottom limit was to be safely above the explosive range of the mixture.

The appliance burners in operation on undiluted coke oven gas were assumed to be of the proper design and all in good adjustment in all departments.

An interesting fact in the combustion of all fuel gases is that the quantity of air which is, of course, the source of the oxygen required, is approximately constant regardless of the type of gas used. Furthermore, the combustible mixture of the fuel gas and air emitted from a burner nozzle is always approximately 100 B.t.u. per cubic foot, neglecting the inerts such as nitrogen and carbon dioxide in the gas served to the burner. As an example, natural gas of 1000 B.t.u. per cubic foot requires about 10 parts of air to make a combustible mixture; manufactured gas of 530 B.t.u. per cubic foot about five parts of air; butane of 3200 B.t.u. per cubic foot requires about thirty parts of air and propane at 2537 B.t.u. about twenty-three point four (23.4) parts of air. When these facts are taken into consideration, it will be readily seen that the burners now installed on all furnaces were already equipped with proper inspirators and mixers to supply the proper amount of air for the combustion reaction necessary to maintain continuity of temperature and atmosphere on each furnace or appliance.

The next consideration was that of B.t.u. input with the blended gases, through the same burners to produce the required amount of heat. This could be done in three ways:—the orifice size in the burners could have been made adjustable to compensate for a change in thermal value or gravity; the delivery pressure at the orifice could be varied or the thermal value of the blend could be changed to some other value than 500 B.t.u. coke oven gas to compensate for the change in gravity.

The first two courses were eliminated, because of their impracticability.

In the liquefied petroleum gases of either the pariffin or olefin series, there is a close relationship between the specific gravity of these relatively pure hydrocarbons and their respective thermal values.

For example, the only control of thermal value necessary in a butane-air or propane-air gas plant is a specific gravity controller, such as a Ranarex, used by boiler plants as a stack CO_2 control. There are many small town gas plants using this system in the United States today.

When an increase in gravity of the blended gases is accompanied by a fairly constant rise in thermal value, it is only necessary to select a blend of the proper gravity at the same line pressure as established for the undiluted coke oven gas that would deliver the required number of B.t.u. through the gas orifice on the burners as adjusted.

The problem had now resolved itself into one which could be solved mathematically. As an example, on the hypothesis that it is desired to replace a 500 B.t.u. .47 gravity coke oven gas, with a butane-air mixture to function with equal efficiency without burner readjustment at the same line pressure as coke oven gas:—

Let T = the thermal value of the desired butane-air blend

3200 = B.t.u. of butane
1.95 = specific gravity butane (air = 1)
500 B.t.u. of coke oven gas blend
.47 = specific gravity coke oven gas blend

Then

$$\frac{500}{T} = \sqrt{\frac{.47}{\left(\frac{T}{3200} \times 1.95\right) + \left[\left(1 - \frac{T}{3200}\right) \times 1\right]}}$$

Clearing,

$$\frac{250{,}000}{T^2} = \frac{.47}{\frac{1.95T}{3200} + \frac{3200}{3200} - \frac{T}{3200}}$$

$$\frac{78}{T^2} = \frac{.47}{1.95T + 3200 - T}$$

$$.47T^2 = 73.1T + 249{,}600$$
$$T^2 = 155T - 531{,}000$$
$$T^2 - 155T - 531{,}000 = 0$$
$$(T - 811)\quad (T + 656) = 0$$
$$T = 811 = \text{B.t.u. Value of Blend}$$

The mixture was set at 811, however this mixture showed slightly lean on the burners located some disdance from the source. The blend was increased in thermal value to 850 where it is now operating. This slight increase in thermal value necessary was probably due to the greater drop in line pressure due to the blend being of greater density than the 500 B.t.u. coke oven gas.

The greatest advantage in handling blended gases on a combustion basis is that a change from one gas to another can be made with little or no effect on the appliance. Another advantage is that variable percentages of the two or more may be sent out simultaneously with no burner adjustments or change in furnace atmosphere. We were taught that things equal to the

same thing are equal to each other. Therefore, as quality and production must be maintained, good combustion is the thing.

In closing, I wish to thank Ford Motor Co. for their help in making this data available for the preparation of this paper.

DISCUSSION

PRESENTED BY

M. J. CONWAY, Fuel Engineer, Lukens Steel Company, Coatesville, Pa.

E. L. TINDALL, Fuel & Power Engineering Dept., Carnegie-Illinois Steel Corp., South Works, Chicago, Ill.

K. EMMERLING, Assistant General Superintendent, East Ohio Gas Company, Cleveland, Ohio.

M. J. CONWAY: This paper by Mr. Harlow is interesting in that it describes a method of bringing together two by-products of different industries, blast furnace gas from the Steel industry, and butane from the Petroleum industry, and by a simple, safe way of mixing, provides a new high form fuel equal to coke oven gas in heating qualities, and making up the deficiency of luminosity in blast furnace gas.

I feel sure that we will hear more about plants of this kind. Butane is naturally a "dry" gas and I would like to know from Mr. Harlow if there has been any difficulty due to valve packing shrinkage in the distribution mains of the mixed gas? Are there any luminous flame burners in use on this mixed gas service?

E. L. TINDALL: In his presentation of this discussion of the distribution of different gaseous fuels in the Ford Motor Company plant, Mr. Harlow has covered a subject of great interest to all steel plants where the utilization of by-product fuels is of vital importance to the most economical plant operation. This subject embraces such a large field that details of particular application problems which must have been encountered when the blends of the several gases were first used, were not fully discussed. It appears that a supplementary paper covering these details would be of great interest.

It is with particular interest that we note that Mr. Harlow balances exactly the blast furnace gas produced against that distributed without accounting for any gas bled to atmosphere, and this without holder capacity which would minimize the effect of fluctuations in blast furnace gas supply. It has been our experience that full utilization of this gas is extremely difficult where the demands of heat control are very exacting because the normal fluctuations during casts on the furnaces or during "hanging" periods may be rather severe, enough so that the control of heating furnaces is adversely affected. It would be of interest to know how such variations are compensated for in this particular distribution set-up.

In controlling the gas distribution it is apparent that curtailment of the supply to some consumers may be necessary at any time. It would be of interest to know what consumers are the most easily changed over to oil fuel and what the Ford engineers experience has shown relative to the preference that should be given certain consumers for continuous use of gas over those using this fuel for other and different classes of work.

During our study of Mr. Harlow's paper, several other questions have occurred to us which we offer with the intention of providing a basis for further discussion of this subject if an opportunity for such a symposium is presented.

1. Although it is true that a "heavy" gas can be more easily held in close contact with a bath, either glass or metal, it is our experience that, with proper control of air velocities and the mixture of gas and air, this result can be accomplished with gases of lower relative density than the liquified petroleum gases mentioned.

2. It would seem that the difference in flame velocities between coke oven gas with a flame velocity of 2.3 feet per second, and the mixed air or blast furnace gas and petroleum gas with a flame velocity of approximately 1.0 foot per second would cause considerable difficulty from the stand-point of flame retention on cold furnaces.

3. In the arrangement of the mixing station, the combination of Connersville blowers is made so that either air or blast furnace gas can be introduced as the dilutent for the petroleum gas while the calorimeter controls the final mixture to a constant B.t.u. setting. It is necessary with variations in the amount of blast furnace gas introduced to change the eventual B.t.u. of the mixture although the specific gravity of the blast furnace gas and air are the same?

We wish to compliment Mr. Harlow upon his presentation of this paper since it concerns a subject which is becoming increasingly important in the fuel balance of the Steel Plant.

K. EMMERLING: Any steel plant that wishes to make the best possible use of the gaseous fuel generated in its own plant must provide more points of usage than the available supply can take care of, during peak operation; otherwise gas will have to be wasted during shutdown periods.

If more gas burning equipment is provided than the normal supply of gaseous fuel generated in the plant can take care of, the deficiency must be provided for either by using a liquid fuel or by purchasing from an outside source a gas which can be used to make up the deficiency. The gases generally used to make up such deficiencies are natural gas, refinery gas, and liquefied propane and butane. All three of these must be modified by mixing with air, blast furnace gas, or inert gases

such as flue gas, if they are to be used interchangeably with coke oven gas or coke oven gas-blast furnace gas mixtures, the amount of modification depending upon which of the three gases is to be used as a makeup.

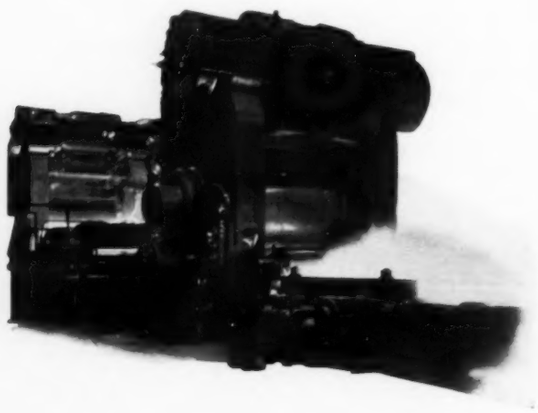
As Mr. Harlow points out, there is only one practical way of doing this, namely, by adjusting the heating value in the makeup gas to such a degree that the burners on the furnaces, which are designed for the use of the steel plant's own gas, can properly burn the makeup gas in sufficient quantities to provide the required heat. The gas pressure, of course, must remain the same, regardless of which of the gases is used.

In designing and operating a gas distribution system to meet the above needs, there are a number of precautions to be taken:

1. Accurate mixing must be provided. Unless the heat value of the modified makeup gas remains constant, furnace operation with the makeup gas will never be satisfactory. There are a number of very practical ways of doing this. Inasmuch as the mixing station must respond to varying demands for makeup gas instantly, it should be as nearly automatic as possible, and so designed as to respond ,with practically no lag, to pressure drops in the distribution system, for in most cases it is the drop in pressure in the gas lines which cuts the substitute gas in and out.
2. Distributing mains should be large enough to insure sufficient pressure at the furnaces farthest from the point of supply, when the higher gravity gases are used.
3. It is advisable to carry the pressures in the mains somewhat higher than is required by the furnaces, and then to reduce the pressure to that needed at each furnace, or even at each bank of burners if the furnaces are large and have more than one bank of burners. If this is done, heating operations on one furnace, or on one bank of burners, will not be interfered with by the lighting up or shutting down of another furnace.
4. As the operation of a system of this type is dependent entirely on accurate control of pressures, a great deal of thought should be given to the pressure regulating devices to be used. It does not pay to try to save money on regulators if really good furnace operation is desired.
5. Even though a system designed for the use of a steel plant's own gas and a modified purchased gas can be made automatic, it is still necessary that an effective and well thought out dispatching system be put into effect, the dispatcher to have sole authority as to how fuels are to be used. The above is particularly true if liquid fuels are also to be used as a makeup.
6. In order that a large gas distribution system function properly, it is essential that all automatic controls of one kind or another be properly maintained, and someone should be appointed who is to be responsible for the maintenance and repair of this equipment. Sufficient spares should be kept on hand to provide for constant operation.

The choice as to whether a liquid or a gaseous fuel is used as makeup is dependent in a large measure upon their relative prices. It should be borne in mind, however, that furnaces designed for burning one type of fuel only are generally more efficient than those designed for the use of several types, and a heating job can generally be done with fewer BTU's per unit of work heated when a high heat value gas is used in properly designed furnaces than is the case where liquid fuel, or, for that matter, low heat value gases such as producer gas and blast furnace gas are used.

In concluding, I would like to take this opportunity to compliment Mr. Harlow upon his very fine and comprehensive paper on a subject which, at the present time, is occupying the attention of many steel plant executives.



HEAT TREATING

Furnace Specifications

By NORMAN C. BYE, Chief Engineer
Henry Disston & Sons, Inc.
PHILADELPHIA, PA.

Presented before the Philadelphia District Section A. I. & S. E., February 6, 1937.

▲ PLUS or minus ten degrees as a permissible variation in temperature was sometimes given as a uniformity specification to obtain the desired result in the finished product. More exacting steel requirements and inspection have made it necessary to extend these specifications so that now it is exceedingly difficult to establish present day heat treating furnace specifications which will give results satisfactory to the operating department and still be acceptable to the furnace builder.

The items of physical dimensions, weight of charge, maximum temperature, type of heating, and economy of operation are usually easily established. The items of operating characteristics which are based on the desired result in a product are more of a stumbling block and among these items is temperature uniformity which is particularly deceptive because of its seeming simplicity.

This specification is set up as a result of laboratory experiments which show that the desired metallurgical changes take place in the material within certain temperature ranges and that injurious effects, either from overheating or not accomplishing the results, are encountered beyond that range. Usually the specification for temperature uniformity is taken directly from these experiments and is defined as a uniformity of plus or minus a certain number of degrees from a predetermined temperature under operating conditions.

As the operating conditions vary widely with different processes, we will take a specific case of a car type furnace, pack annealing sheet and bar steel in boxes and pipes as this will bring out many of the points to be considered. Temperature uniformity in this case is usually defined as plus or minus ten degrees from the annealing temperature at all points within the working zone of the furnace after the furnace and charge have come up to temperature. From a user's standpoint, this seems like a close specification but it would be interesting to know how this specification is used in the design of a furnace. So let us imagine we are furnace builders and see what it would mean to us.

Suppose we need a car type furnace to handle charges of a specified cross section and length, fired with gas at a specified heating rate, cooling rate, and of a large enough size to warrant a zone control and a plus or minus ten degree uniformity specification. The first step is to lay out the size of the working zone from the size of the charge. We will assume three different charges, for example a pipe charge and two box charges of different physical dimensions, all of which will be within the same cross sectional area. These charges will have different surface volume ratio and different centers of mass which means different thermal loads.

As the furnace is gas fired, it will require an inside furnace dimension for combustion gas circulation and distance from the burner of a certain amount at the side, top, and under the charge. The cooling rate of the furnace is specified not to exceed a certain amount at a certain temperature which will require a calculated wall thickness of a known refractory. The furnace is to come up to temperature within a certain time so the total of the furnace losses, the heat absorbed by the refractory and that portion of the charge heated within that time establishes the required heat input. We will split this up into as many units as possible consistent with good burner control and equipment cost and spread these units throughout the furnace to give good circulation, balance the furnace radiation and leakage losses where they occur as well as balance an even absorption of heat by the charge throughout the working zone. As the furnace is of an appreciable size, we will separate it into as many sections or zones under individual control as the customer's price will stand.

Now we come to temperature uniformity, but from the specification this is only considered when the furnace and charge have reached the desired temperature. At this point, the charge is taking no heat. The furnace itself is losing heat evenly and as we have previously balanced our heat input to match the furnace losses where they occur and have provided an even heat input into a working zone which at this time is requiring nothing, there is little else we can do and so, as a furnace builder, we offer up a prayer and let it go at that.

Please note that I have said this is in imagination only but if our imagination is even fair, a set of operating conditions is usually found under which the fur-

nace meets the specifications. However, if the operating department standardizes on these conditions over their entire range of work, it is unusual to obtain consistently good results so something must be lacking.

As previously stated, the specification was based on laboratory experiments and their results are without question. The laboratory, however, deals with small pieces whereas now we are dealing with large masses which require a long time to heat through and time at temperature in some cases can be as detrimental as incorrect temperature. Therefore, any good specification should consider the effect of time.

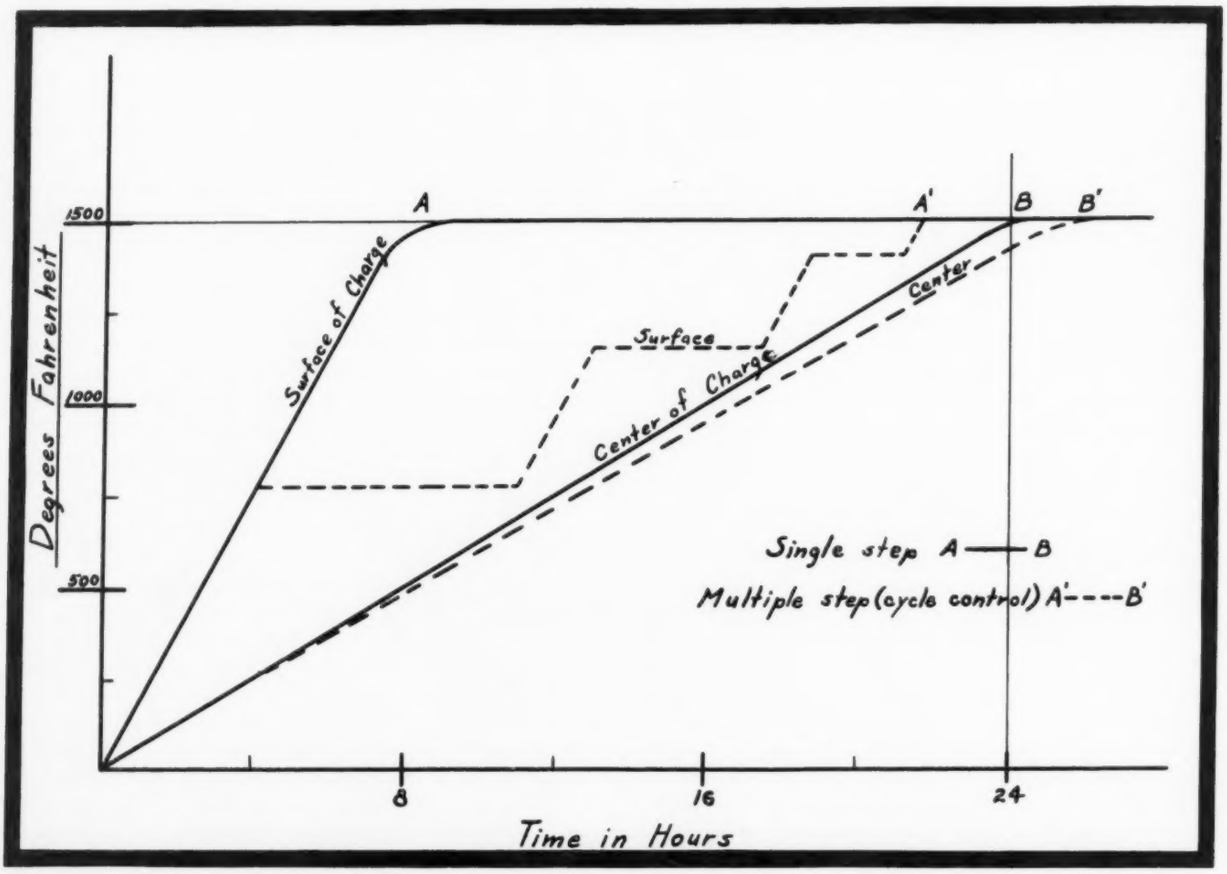
If you plot a simple heating curve for a large annealing charge, it will look like Fig. I in which one line is the temperature of the surface of the charge and the other line is the temperature of the center of the charge. The surface of the charge comes up to temperature at "A" and depending on the size of the charge, the center comes up to temperature many hours later at "B". Our uniformity specification, however, only holds at "B" so anything that happens from A to B when part of the charge is up to temperature is not covered by the specifications. During this time, the furnace is in a state of thermal unbalance as the thermal load is shifted continuously from a combined furnace and charge load at "A" to a furnace load only at "B". It is only necessary to imagine two charges of different physical dimensions with corresponding different thermal loads to see the impossibility of obtaining uniform temperature conditions during this stage with a fixed heat distribution input. In addition to this, the surface of the charge is at the required temperature so long before the center of the charge comes up that the uniformity of the product is questionable. Therefore, good practice should consider uniformity during all the time any part of the charge is at temperature as well as the total time at temperature.

A furnace is really only a tool which is capable of being controlled to meet various conditions. All controls should have a relatively equal degree of fineness as it is not sufficient to have accurate control at one stage and coarse control at another. Even if the controls are provided, the operating department must make the best use of them to suit varying conditions, so the cooperation of the builder and user is necessary for best results.

To the builder, a furnace is merely an insulated container which he fills with BTU's and in which the work is immersed so he is responsible up to the surface of the charge. The operating department by changing the shape and mass of the charge can vary the thermal loads and the time to heat through so they are responsible from then on.

Initially, the operating department should plan their

Figure 1—Heating curve for ten ton car-type annealing furnace.



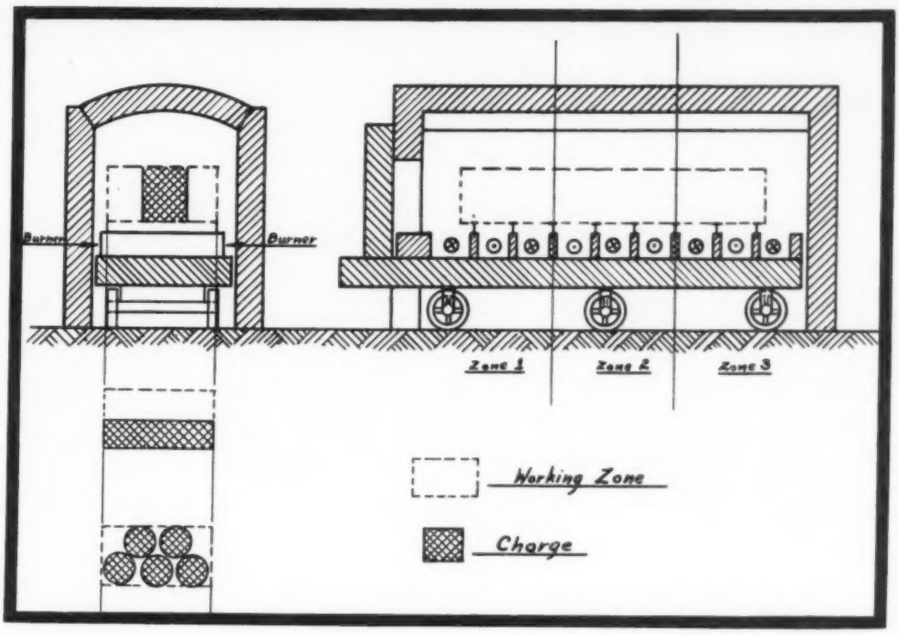
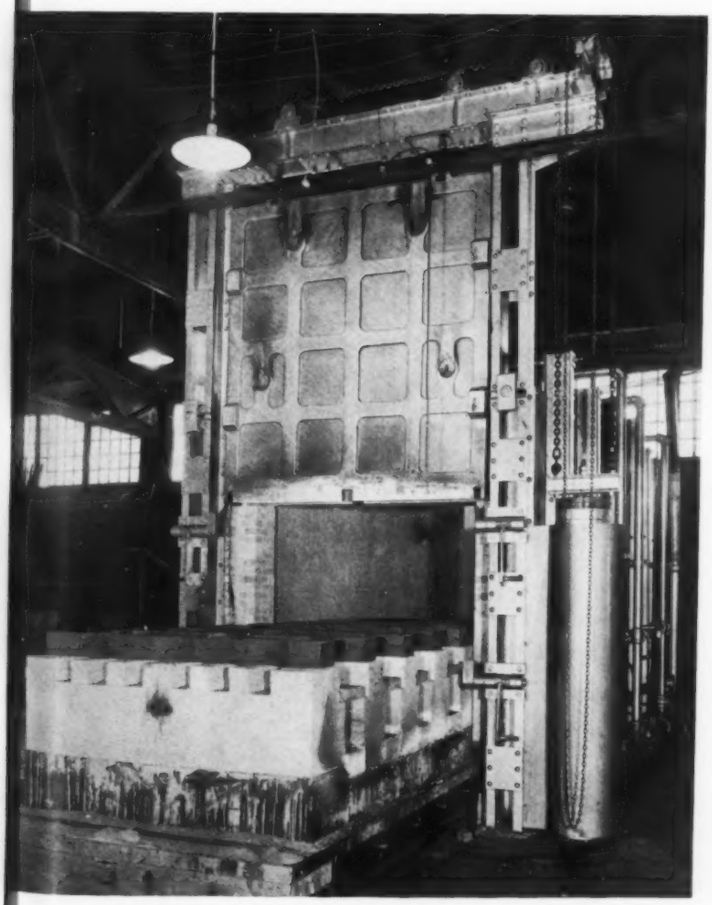


Figure 2—Working zone and burner arrangement of typical car type furnace.

Figure 3—Front view showing car and lifting mechanism of the car-type annealing and carbonizing furnace.



charges with as large a surface volume ratio as is economically possible because, generally speaking, the larger the surface in proportion to the mass, the quicker the center will come up to temperature. These charges should be studied to determine their effect on point of thermal load and heat circulation in the furnace. The furnace builder should then provide means to permit flexibility of heat distribution within the zone, either by shutting off burners, baffling, venting, or reducing the heat in certain sections of electrical resistors to compensate for these different thermal loads. These means should enable the furnace to meet a specification so that all points on the surface of the charge will be within certain limits of temperature uniformity during the entire time the surface is in the danger range for any particular material. These means should then be used by the operating department to change the heat distribution to suit varying load conditions and in addition, the furnace should be operated on a cycle control which will bring the furnace and surface of the charge up to the desired temperature in steps to still further shorten the lag of the center behind the surface. This is shown by the dotted line in Fig. I. Under these conditions, the temperature of the surface of the charge will be uniform and the time at which all points of the charge are brought to balance is kept as short as possible so good results cannot help but be obtained.

This specific case deals with a batch type furnace only but in the establishing of any temperature uniformity specification, greater benefits can be obtained by making a closer study of the effect of mass and time and laying less stress on extreme accuracy of temperatures. Until then, the question of plus or minus ten degrees, where it is taken and how, is of minor importance and does not deserve the publicity it has been having.

WARD LEONARD CONTROL

For Blooming and Slabbing Mill Auxiliaries

By W. B. SNYDER, Industrial Dept.
General Electric Company
SCHENECTADY, N. Y.

Presented before the A. I. & S. E. National Meeting, Youngstown, Ohio, February 25, 1937.

▲ FOR many years, engineers have been considering the use of Ward Leonard control for operating large heavy duty auxiliaries in steel mills, but, until recently, only occasional applications have been made. Therefore, the installation of this type of control on the screw-downs, side-guards, live tables, and shear of a 46″ x 104″ slabbing mill at the plant of the Inland Steel Company has aroused wide interest.

Before describing these drives in detail, it might be well to consider the reasons for the use of Ward Leonard control:

First, and most important, is fast operation. Due to its inherently smooth and stepless action, higher rates of acceleration and deceleration can be obtained than with magnetic control. Also, it permits operating the motors at over-voltage, thus providing higher top speeds than are obtainable with magnetic control.

Next, a material reduction in mill delays and in maintenance expense may be expected if Ward Leonard control is used in place of magnetic control, since the operation of the motor is controlled by small contactors handling currents well below their continuous rating, rather than by large heavy contactors handling peak currents of from 2 to 3 times their rating.

Furthermore, Ward Leonard control is very flexible and may be adjusted in the field to give a wide range of characteristics, simply by changing the values of resistance in the generator field circuit. This permits the electrical equipment to be "hand tailored" to the drive.

Finally, power costs per ton will be less than with magnetic control, since resistor losses are practically eliminated, and since regenerative braking permits energy to be returned to the power line during deceleration.

To offset these advantages, Ward Leonard control has one disadvantage. That is, it requires a separate generator for each drive, and thus the first cost is usually higher than the cost of magnetic control. However, in comparing the two types, it should be remembered that either type will require AC to DC conversion equipment. Such equipment for Ward Leonard control is more expensive only because smaller generators cost more per kw, and because it is impossible to allow any diversity factor in the determination of generator capacity. On the other hand, the increased cost of conversion equipment is partially offset by the decreased cost of the control panels, and, on very large drives, Ward Leonard control may actually be lower in first cost.

These features are common to all types of Ward Leonard control. However, there is a special form which possesses several advantages over the conventional type. In this form, a 3-field generator is used as a source of power for the driving motor. This is the type of control installed on the drives mentioned above.

The 3-field generator has, in addition to the usual separately excited shunt field, a self-excited shunt field, and a heavy series differential field. The combined effect of these three fields produces a volt-ampere characteristic like that shown in Fig. 1.

Fig. 1 applies to a 135 kw, 250 volt generator used with a 150 HP, 450 RPM, 230 volt, shunt wound, mill type motor. Curve A shows the characteristics obtained with the separate field excited to the normal value. Under no load conditions, the generator voltage is almost 500 volts, so the motor supplied by the generator runs at something over 200% speed. As the load increases, the generator voltage falls under the combined action of the series and the self-excited shunt field, until at full load (535 amps.), the voltage is about 420 volts. Here the motor is developing full load torque at almost double speed. As the load torque increases, the generator voltage continues to fall until, at 40 volts, the generator current reaches a maximum value of 1310 amperes. Since 40 volts corresponds approximately to the IR drop in the armature circuits of the motor and generator at this current, the motor stalls at about 250% torque.

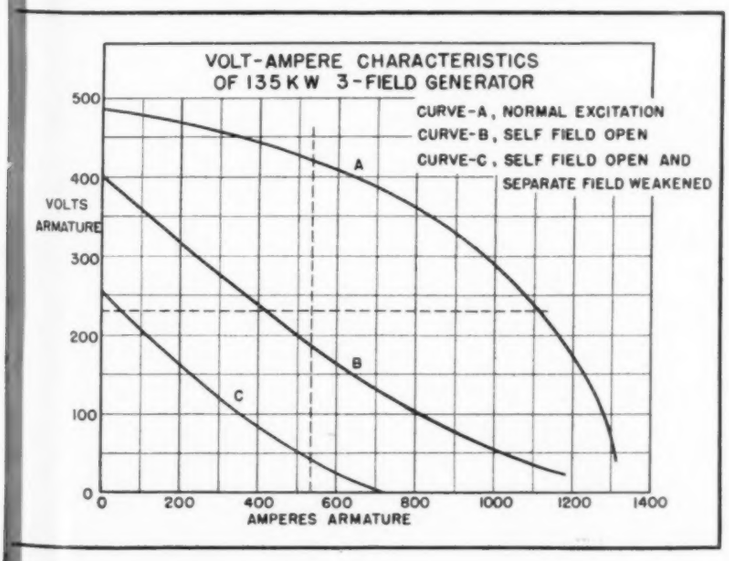
A characteristic such as this provides several operating advantages on blooming mill auxiliary drives. First, the maximum torque is definitely limited to a value well within the commutating capacity of the motor, without the use of series resistors, jamming relays, or load relays to weaken the generator field. The mechanical parts of the drive are relieved of excessive stress, and the danger of breaking shafts, couplings, or gears, is practically eliminated. This feature is particularly valuable on sideguard drives, which are subject to frequent jamming, and is also desirable on screw-downs, in case of over-travel of the screws, and on shears, in case an attempt is made to shear a section beyond the capacity of the drive.

Next, at loads of the order of full load torque, or less, the motor runs at about twice normal speed. Thus, on screwdowns and tables, high speeds are automatically obtained on long travel, giving the drive the charteristics of series-parallel control without requiring any switching of the armature circuits. This characteristic is also valuable on the side-guards and shear, because the high speed to which the motors will accelerate provides greater stored energy, which is available for useful work in straightening or shearing a bloom.

Finally, the characteristics of the 3-field generator permit the motor to develop its maximum value of torque almost instantly after the starting indication is given, and the motor torque falls off only slightly as the speed increases to the normal full load value. Thus, the average accelerating torque is greater than can safely be obtained either with magnetic control or with conventional Ward Leonard control. These higher torques produce faster operation, which tends toward increased mill production.

The characteristics of the shovel generator may be varied widely by adjusting the relative strength of its two shunt fields. For example, by weakening the separately excited field and leaving the self-excited field unchanged, a family of characteristics roughly parallel to curve A are obtained. If the separately excited field is left at the normal value and the self-excited field is opened, the generator will operate on a curve similar to Curve B in Fig. 1. Further weakening of the separate field will provide other characteristics parallel to curve B. The one shown by Curve C of Fig. 1 is actually used on these drives, to provide an inching point.

Figure 1—These curves apply to a 135 KW, 250 volt generator used with a 150 HP, 450 RPM, 230 volt, shunt wound, mill type motor.



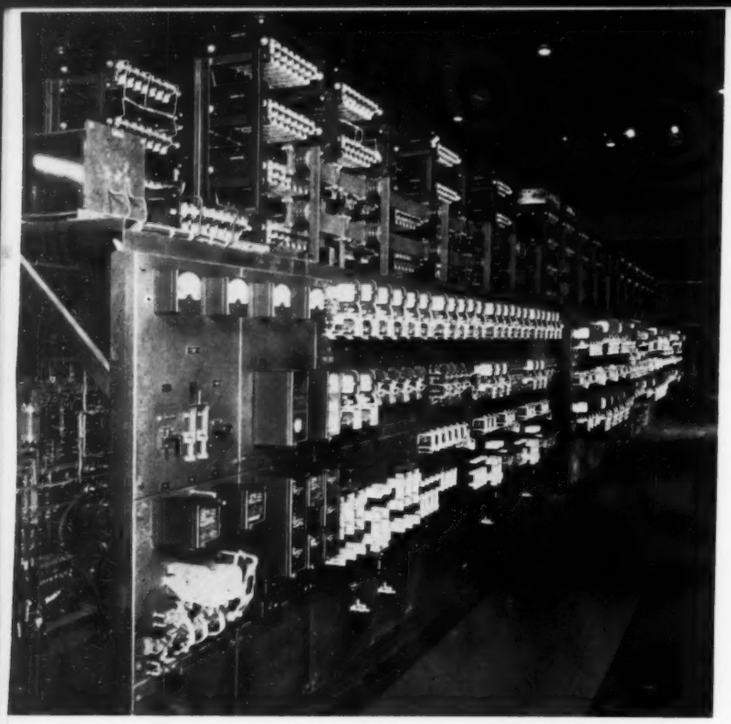
W. B. SNYDER

ARRANGEMENT OF DRIVES

The Ward Leonard controlled auxiliaries of the 46″ mill are arranged in the following manner:

Screw-downs

The screws are driven by two type MD-418, 150 HP, 450 RPM, 230 volt shunt wound motors, each equipped with a shunt brake. If these motors had been operated by magnetic control, they would have been made compound wound, and reversing-plugging-dynamic braking series parallel control would have been used. Long screw travel would have been accomplished on the parallel connection, and the motors would have operated at normal speed at full load torque. Equivalent results could be obtained on Ward Leonard control by connecting the motors permanently in series and supplying them from one 3-field generator with characteristics as shown in Fig. 1. However, it was felt desirable to provide still faster operation, so two such generators, each supplying one motor, were used. With this arrangement, the motor operates at nearly double speed at full load torque. Due to the dropping characteristics of the 3-field generator, the motors share the load equally without the necessity of cross connected fields.



Group assembled control in back to back arrangement, for Ward Leonard operated auxiliaries.

Side-guards

The left and right side-guards are each driven by two MD-418 shunt wound motors, each with a shunt brake. The motors are connected permanently in series, and each pair is supplied from one 135 Kw generator. If magnetic control had been used, it would have been of the reversing-plugging-dynamic braking type, with jamming resistor, arranged to operate the two motors permanently in series.

Tables

The front and rear tables are each driven by two MD-418 shunt wound motors connected permanently in series, each pair of motors being supplied from one 135 KW generator. Provision is made to transfer the table generators from the characteristics shown by Curve A of Fig. 1 to the characteristics shown by Curve B after the voltage has built up to a predetermined value. This limits the top speed of the table to a reasonable value on long passes. The operation is somewhat comparable to that obtained by series-parallel control if the parallel connection is used to obtain a high rate of acceleration, and the series connection to limit the top speed. It is interesting to note that this operation requires 9—100 amp. field contactors, plus a few discharge contactors, whereas if magnetic control had been used, 20—600 amp. contactors would have been needed.

Slab Shear

The slab shear is of particular interest since it is one of the few shears in this country on which the motors start and stop for each cut. It is driven by two MD-420 frame shunt wound motors each rated 275 HP, 435 RPM, 250 volt, each with a shunt brake. Each motor is supplied from one 250 KW 3-field generator. The characteristics of these generators are similar to those in Fig. 1, except that the ceiling voltage is increased to 600 volts, and the current cutoff to 1600 amps.

Motor Ventilation

Since these drives are operated practically continuously, they are forced ventilated from an external source of cleaned air. This practice is strongly recommended for mill auxiliary drives in severe and frequent service.

OPERATION OF CONTROL

Fig. 2 is a schematic diagram showing the basic method of control used for all these drives. The motor has its shunt field excited from the 230 volt bus, and its armature solidly connected to the armature of the generator, through the generator differential series field. The separately excited shunt field of the generator is provided with a set of reversing and discharge contactors, and a field weakening contactor, and is also excited from the 230 volt supply. The self-excited shunt field is connected across the generator armature and also has a set of reversing and discharge contactors. The reversing contactors for the self-excited field are used only to provide a "suicide" circuit and are not for directional control. The forward contactors are closed for either forward or reverse operation.

With the Master switch in the "off" position, the drive is at rest with the separately excited field open and the self-excited field on suicide. Advancing the Master switch to the first point forward closes the forward and the field weakening contactors in the separately excited field circuit and opens the reverse contactors in the self-excited field circuit. This applies full excitation voltage to the separately excited field, and the generator voltage builds up rapidly to a characteristic similar to Curve B in Fig. 1. If the Master switch is left at this point, a definite time relay opens the field weakening contactor, reducing the strength of the separately excited field, and transferring the generator to a characteristic similar to Curve C.

If the Master switch is thrown directly from rest to the second point forward, full separately excited field is applied, and the self-excited field is connected across the generator armature in the normal direction. The generator voltage then builds up to a characteristic similar to curve A of Fig. 1.

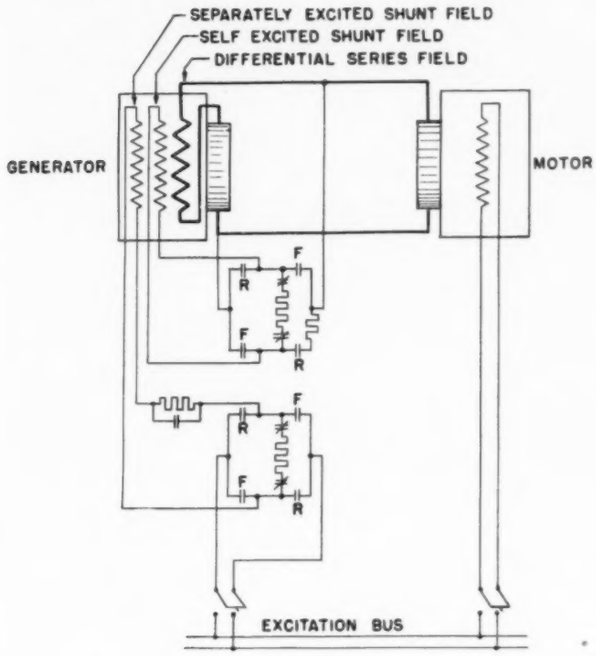


Figure 2—Schematic diagram showing thc basic method of control used for the drives discussed in this paper.

If the Master switch is thrown directly from the second point forward to the second point reverse, the separately excited shunt field is energized at full strength in the reverse direction. This causes the motor to decelerate rapidly to rest, and then to accelerate in the reverse direction. This is not a plugging operation, although it is often so called. Instead, deceleration is accomplished by regenerative braking, as the effect of the generator series field is to hold up the voltage in the forward direction to a value which limits the pump back current to a safe figure until deceleration is complete. Then the generator builds up its voltage in the reverse direction on a characteristic similar to curve A of Fig. 1.

If the Master switch is moved from a running point to the "off" point, the separately excited field is opened, and the self-excited field is connected across the armature in the reverse direction. This provides rapid regenerative braking to rest, as the suicide effect of the self-excited field tends to compensate for the cumulative action of the series field on regeneration.

It will be observed that there is no contactor or circuit breaker in the armature circuits of the motor and generator. The self-protecting characteristics of the 3-field generator render such protection unnecessary. However, as a safety measure, an overload relay is provided in the armature circuit to open the generator field contactor in case of overload. Such overload could occur only by the accidental short circuiting of the series resistors which are installed in the generator field circuits to insure rapid response.

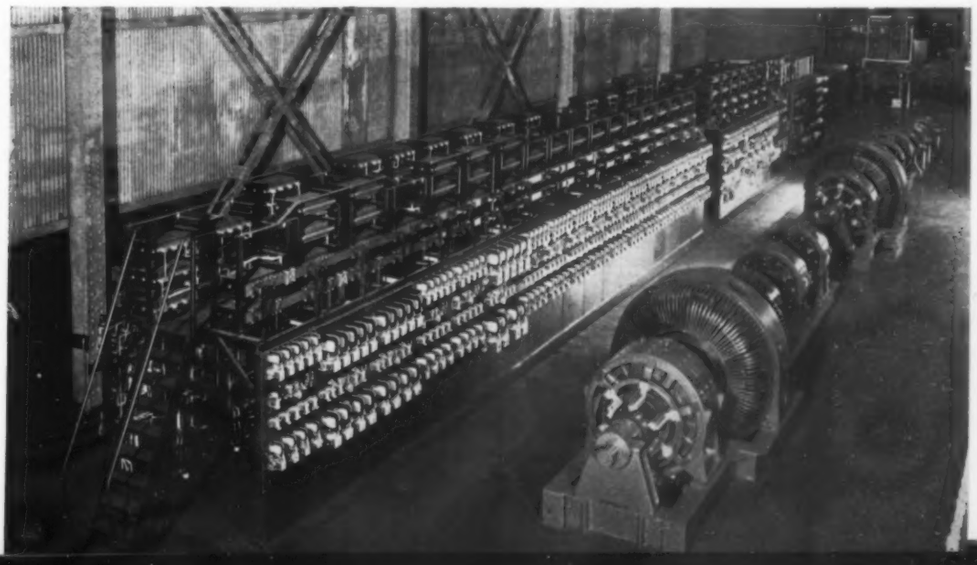
The method of control applies with minor variations to all the drives. For example, the table drive will, as mentioned before, automatically transfer itself to a lower speed characteristic if left on the full speed connection too long. The shear drive is stopped automatically by a geared limit switch which first transfers the drive to a slow-down connection, and then stops it by regenerative and mechanical braking. On the screw-down and shear drive, in which two generators are used, the separately excited fields are controlled in parallel from one set of contactors, and the self-excited fields are controlled independently.

ARRANGEMENT OF GENERATORS

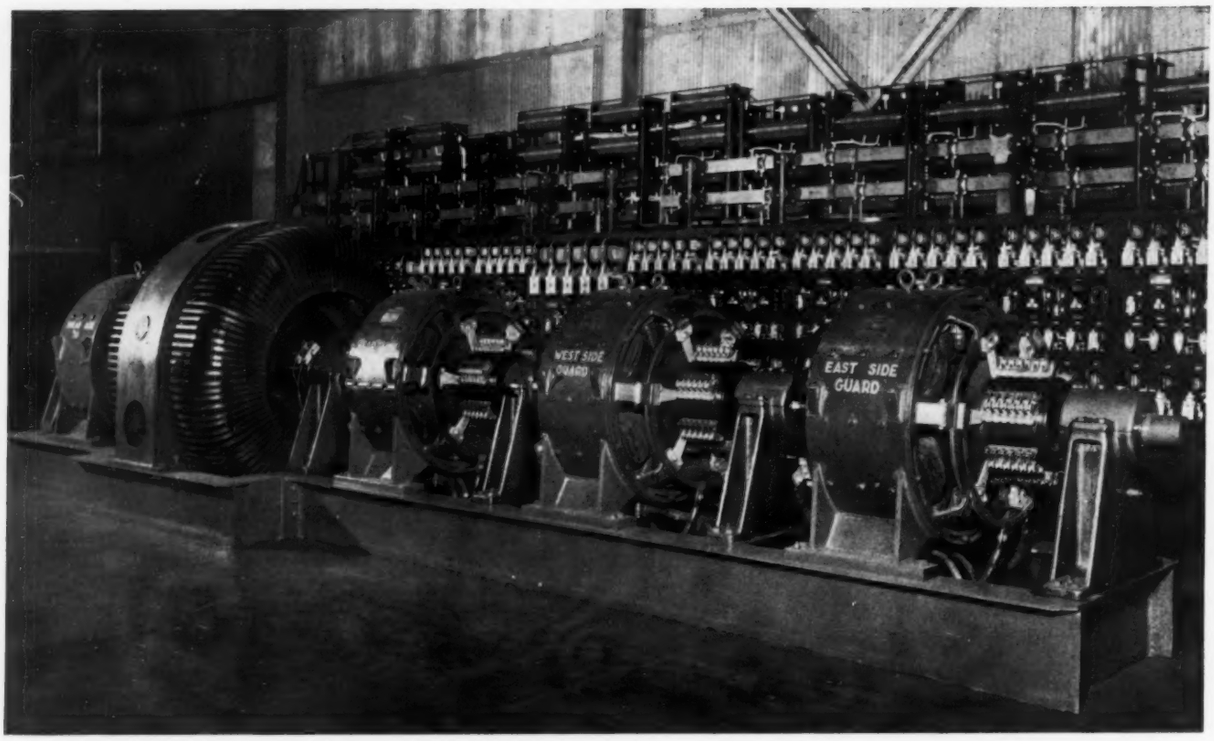
Eight generators are used to supply the six drives, two 250 KW machines for the shear, and six 135 KW machines for the other drives. These are grouped into two synchronous M-G sets, each consisting of 1—250 KW and 3—135 KW generators, driven by a 1000 HP, 750 RPM, 6600 volt synchronous motor. Provision is made on each of these sets for the addition of a future generator, suitable for use as a spare to either a 250 KW or a 135 KW machine. However, the transfer arrangement provided in the control renders a spare generator practically unnecessary.

Transfer Arrangement and Spare Capacity

As noted before, the shear drive is supplied from two 250 KW generators, and the screw-down drives from two 135 KW generators. Transfer switches are



View of slabbing mill motor room showing three field generator sets supplying Ward Leonard operated auxiliaries. The group assembled control in background shows the first section, used for magnetically operated auxiliaries while the second section is for Ward Leonard operated auxiliaries.



One of two 3 field generator sets, each including one 250 KW generator and three 135 KW generators, for shear, screw-downs, tables and manipulators operated under Ward Leonard control.

provided on the control panels so that in case of failure of one shear generator, the two motors may be connected in series across the other generator, permitting the shear to operate with full cutting effort but at lower speed. Transfer switches are also provided so that if one 135 KW generator fails, the screw-down motors may be operated in series from one generator, and the other used as a spare for the machine in difficulty. In addition, a complete spare synchronous motor is available for substitution on either set.

ARRANGEMENT OF CONTROL PANELS

The control panels for the Ward Leonard controlled auxiliaries, as well as for the 25 other magnetically controlled auxiliaries, are mounted in a back-to-back arrangement on self-supporting frame-work. This structure was completely assembled at the factory, with resistors, buses, and connections mounted and wired, and all outgoing connections brought to terminal boards. The structure was divided into lengths convenient for shipping purposes. When received at the plant, it was only necessary to skid the sections into place, make the necessary cross connections between sections, and connect the outgoing cables to the terminal boards. It will be readily appreciated that this "group assembled" construction saves a great deal of time and labor during installation. The accompanying photographs clearly show the back-to-back arrangement of panels, with resistors mounted overhead and accessible from a catwalk along the top of the structure.

OPERATING RESULTS

As yet, very little operating data are available on these Ward Leonard drives. However, such data as has been obtained indicate extremely desirable performance. The drives were put into service about 5 months ago, and went into full operation without any changes, and with only minor adjustments in the values of generator field resistance. So far as can be determined, the maintenance expense has been zero.

In fact, the drives have been responsible for a reduction in maintenance cost of the mechanical equipment. Several conditions have arisen which would usually have damaged gears and shafts, but this damage was prevented by the self-protecting characteristics of the 3-field generators. This has made the mechanical department a firm supporter of the Ward Leonard drives.

The mill operators who have had experience with magnetically controlled drives on a similar blooming mill are particularly pleased with the flexibility and quick response of the Ward Leonard drives. The shear, which is designed to cut sections up to 6″ thick, has actually sheared a 10″ slab on test. The transfer schemes have been tried out, and it has been found possible to operate the screws and the shear from one generator each, at some sacrifice in operating speed.

It is planned to run complete tests on these drives in the near future, and to report the results of these tests in a later paper.

DISCUSSION

PRESENTED BY

J. J. BOOTH, Asst. Chief Maintenance Engineer, Carnegie-Illinois Steel Corporation, Duquesne, Pa.

F. O. SCHNURE, Electrical Supt., Bethlehem Steel Company, Sparrows Point, Md.

J. J. BOOTH: I wish to congratulate Mr. Snyder on his very interesting paper. While Mr. Snyder has not developed a new idea, he has brought out a new application in the use of Ward Leonard control for heavy duty steel mill auxiliaries. It will be exceedingly interesting two or three years hence to be able to check the actual operation and maintenance of this equipment from the standpoint of costs; also to get the reactions of the mill operating force as to the general results obtained in ease of operation, smoothness of acceleration and deceleration, and general speed.

There is no doubt or question as to the flexibility of Ward Leonard control. It is inherently faster than the conventional magnetic control generally used on applications of this nature.

We have in our plant several Ward Leonard applications on skip hoists and have found them very satisfactory, both from the standpoint of maintenance, general operation and ease of handling the skip.

The big problem, in my opinion, is to be able to convince, and justifiably so, the increased first cost of this type of equipment over magnetic control which has been used for the past several years.

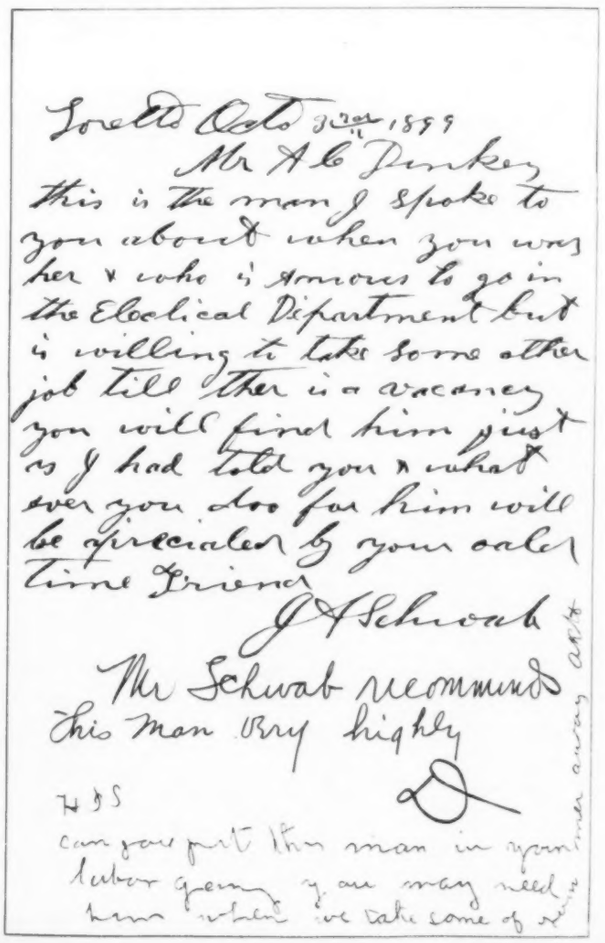
As I see it, we must produce a better product in less time, and with less cost, and with greater ease than in the past, to justify this additional expenditure.

In closing my remarks I wish to congratulate the large steel company for having installed Ward Leonard control, and no doubt they will be able shortly to determine the additional value they may possess.

F. O. SCHNURE: Nine years experience with a Ward Leonard controlled blast furnace skip hoist, which has proven so successful that three others have since been installed indicates to me that the use of Ward Leonard Control on hard worked blooming and slabbing mill auxiliaries will prove eminently successful.

Power consumption, control maintenance, and motor repairs will be lower with this than with rheostatic control. Mechanical maintenance on the mill will be less. Production will be higher. In the mill rolling heavy schedules the above factors will pay a handsome return on the additional investment.

Reproduction of letter given to Mr. Smith by J. A. Schwab.



Loretto Oct 3rd 1899

Mr A C Dinkey

this is the man I spoke to you about when you was here & who is anxious to go in the Electrical Department but is willing to take some other job till ther is a vacancy you will find him just as I had told you & what ever you do for him will be appreciated by your ever time friend

J A Schwab

Mr Schwab recommends this man very highly

H S S

can you put this man in your labor gang, you may need him when we take some of

FRANK I. SMITH NOTED ENGINEER DIES

Frank I. Smith, prominent field engineer for the Otis Elevator Company died suddenly, at his home in Forest Hills, Pittsburgh, April 20. Mr. Smith was a protege of J. A. Schwab, father of Charles M. Schwab, Chairman of the Board, Bethlehem Steel Company.

Mr. Smith, born in Henrietta, Pa., was a telegraph operator for the Cambria and Clearfield Railroad at Crescent when he met the elder Schwab. He expressed a desire to come to Pittsburgh and work in a steel mill, and in 1899 Schwab gave him a letter to A. C. Dinkey, general superintendent of the Homestead Steel Works. The young man was placed in charge of the electrical department at the steel plant and remained there until he went with the elevator company in 1903. He had traveled extensively throughout the United States and other parts of the world in connection with his duties. Mr. Smith was an associate member of the Association for many years.

NEW WIRE MILL

Republic Steel Corporation

SOUTH CHICAGO, ILLINOIS

▲ THE new wire mill built by Republic Steel Corp. at South Chicago was formally opened April 27, when a group including more than 100 agricultural engineers, farm leaders, editors and industrialists visited the plant which has been designed to meet the special needs of rural markets that bought four billion pounds of fence and wire in 1936.

The results of long research by electrical, chemical, metallurgical, mechanical and civil engineers have been pooled in this modern mill, one of the outstanding features of which is a huge electro-galvanizing unit that coats as many as 578 miles of fence wire with 27 close-knit layers of pure zinc in a single day.

"When we decided to go into the manufacture of special steel products for the farm, it was not just with the idea of adding so much tonnage to our total," T. M. Girdler, chairman of Republic, told those present at the opening. "We were determined to contribute something to agriculture, and for that purpose established an Agricultural Extension Bureau with an experienced agricultural engineer in charge.

"We have been conducting extensive research with a view to the proper specification and application of steel products on the farm. This plant is just the first step in a program through which we hope to serve the nation's farms in the same way as we have its industries —with special steels for every special purpose."

Controlled by automatic electrical devices which insure uniform quality in the manufacture of plain and electrically zinc-coated wire, barb wire, woven wire fence, and nails, the mill is served by high-speed mechanical handling equipment that expedites continuous production throughout an area of 177,000 square feet.

The electro-galvanizing line, almost 500 feet long, employs new chemical solutions to etch the wires of copper-bearing steel for perfect zinc adhesion and to transfer molecules of zinc from anodes 99.99 per cent pure, which weigh 30 tons, to the 40 strands of wire which pass continuously through a 13,000 gallon electrolytic bath. Moving at speeds from 35 to 70 feet a minute, depending on the size of wire and the coating to be applied, a single unit turns out enough bright coated wire of average gauge in a fortnight to pierce the earth from pole to pole and leave a 94-mile loop left over.

Coils of steel used throughout the mill are received in the cleaning house direct from the rod storage yard on a 25-ton broadside transfer conveyor, under push button control. They move through acid, rinse, sull and lime tanks, where they are treated under controlled temperature, and then pass along to the bakers, via the same 5-ton roller bearing crane that received them and took them through the cleaning tanks.

A continuous 2 lane conveyor carries the coils through the rod bakers under automatic control and at exact temperatures previous to being transferred to the wire drawing department, where coils are welded end-to-end for continuous drawing through one or another of the high speed wire drawing machines, all with self-contained motors and blocks. These units, some of which are four, five and six draft continuous machines with drawing speeds up to 1400 feet per minute on .0625 inch wire drawn from a .2070 inch diameter rod are likewise served by tramrail hoists and a battery of electric lift trucks which shift the wire to the storage, nail or galvanizing departments.

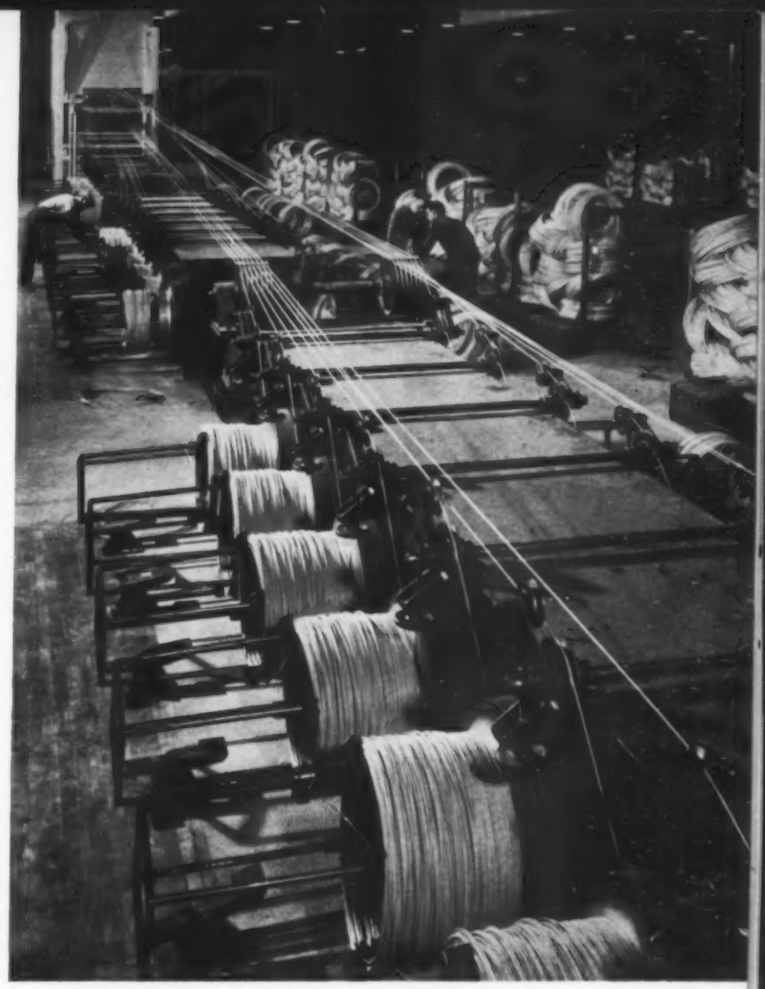
Forty wires pass through a single electro-galvanizing unit in one continuous operation which carries them from pay-off reels, through a lead annealing furnace, a series of electric cleaning and pickle tanks, to the 140-foot electro-galvanizing cell, after a number of intermediate rinses. The wires pass through the plating tank in contact with porcelain insulated fingers an inch or so above the zinc anodes, from which the deposit is carried to the moving strands at current densities up to 1500 amperes per square foot. The finished wire which is plated with an even, ductile coating built up of 27 layers of pure zinc is coiled on three take-up frames which are individually controlled as to speed and have a total of 40 individual reels. The resulting finish is both smooth and pliable, ideally suited for fence because of its workability and high resistance to corrosion.

Approximately 43,000 gallons of solution is required for each electro-galvanizing bath. It circulates through a filter, three 10,000 gallon settling tanks and a cooling tower, all on platforms above the plating line, to insure constant uniformity of finish. Four 15,000 ampere motor generator sets alongside supply power for the electro-galvanizing. Voltage and amperes, as well as the speed of wire travel through the entire line, are controlled from one point, so that all the facts which determine thickness of the coating can be read with one quick glance at the various meters.

Outstanding among many unusual electrical features of this plant is the use for the first time in any American steel plant of direct current supply furnished by a mercury arc rectifier, with automatic voltage control accomplished through electrically energized grids. This 1000 K.W. rectifier is connected through a high speed breaker to the D.C. bus, which is a 9-inch copper channel one-half inch thick, mounted on special insulators and steel beams in the upper part of the connecting tunnels below the mill floor.

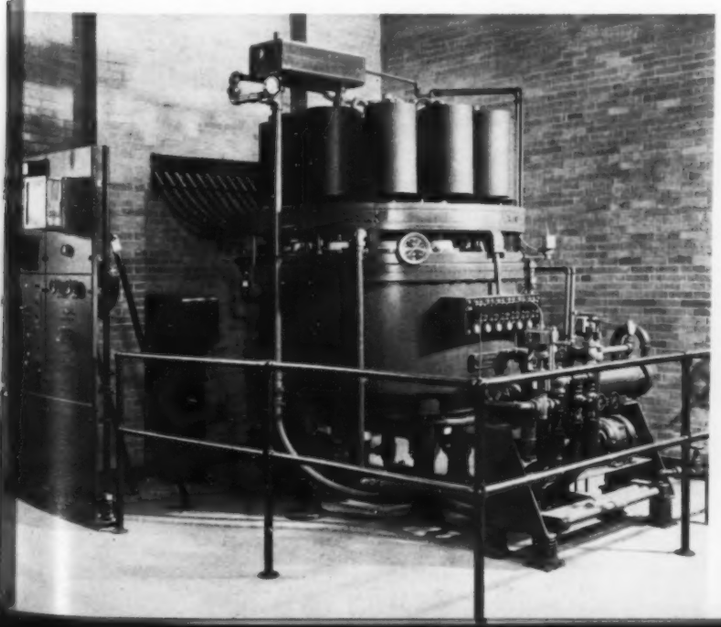
The mill building, designed to meet the specific requirements of wire production, has made use of several modern construction materials especially suited to its needs. Glass brick has completely replaced conventional windows in the cleaning house, where the presence of corrosive acids also dictated the use of steel with $\frac{3}{8}$ inch minimum thickness. Protected metal ventilators and blowers installed in this area and above the pickling tanks, insure adequate ventilation. A metal roof deck has been installed with special insulation over an area totaling 145,000 square feet. Walkways and ladders give access to the roof to permit frequent cleaning of monitors throughout this section of the plant.

Lighting has been scientifically metered to meet the needs of each particular department. Twelve footcandles being provided in the wire drawing room, 8 to 14 foot candles in the galvanizing department, and 15 footcandles in the nail department.



Wire emerges from the 140-ft. electro-galvanizing tank in Republic Steel Corp's new South Chicago wire mill, with a multiple coating of pure zinc, at a rate of 578 miles per day. This view shows some of the take-up reels at the end of the 500-ft. continuous electro-galvanizing line.

For the first time in the history of America's iron and steel industry, a mercury arc rectifier is being used to provide the direct current. This is in Republic Steel Corp's new wire mill in South Chicago. This 1,000 K.W. rectifier is connected to a copper D.C. bus weighing 15½ tons. The bus is a 9" copper channel, ½" thick, the largest section of this type ever rolled.



With all overhead line shafting eliminated by construction of tunnels in which the shafts for these belt drive nail machines are found, Republic Steel Corp's new wire mill is able to obtain closer adjustment of its nail machines and better inspection of product.

HOT AND COLD STRIP MILLS

Granite City Steel Company

By HAYWARD NIEDRINGHAUS, President
Granite City Steel Company
GRANITE CITY, ILLINOIS

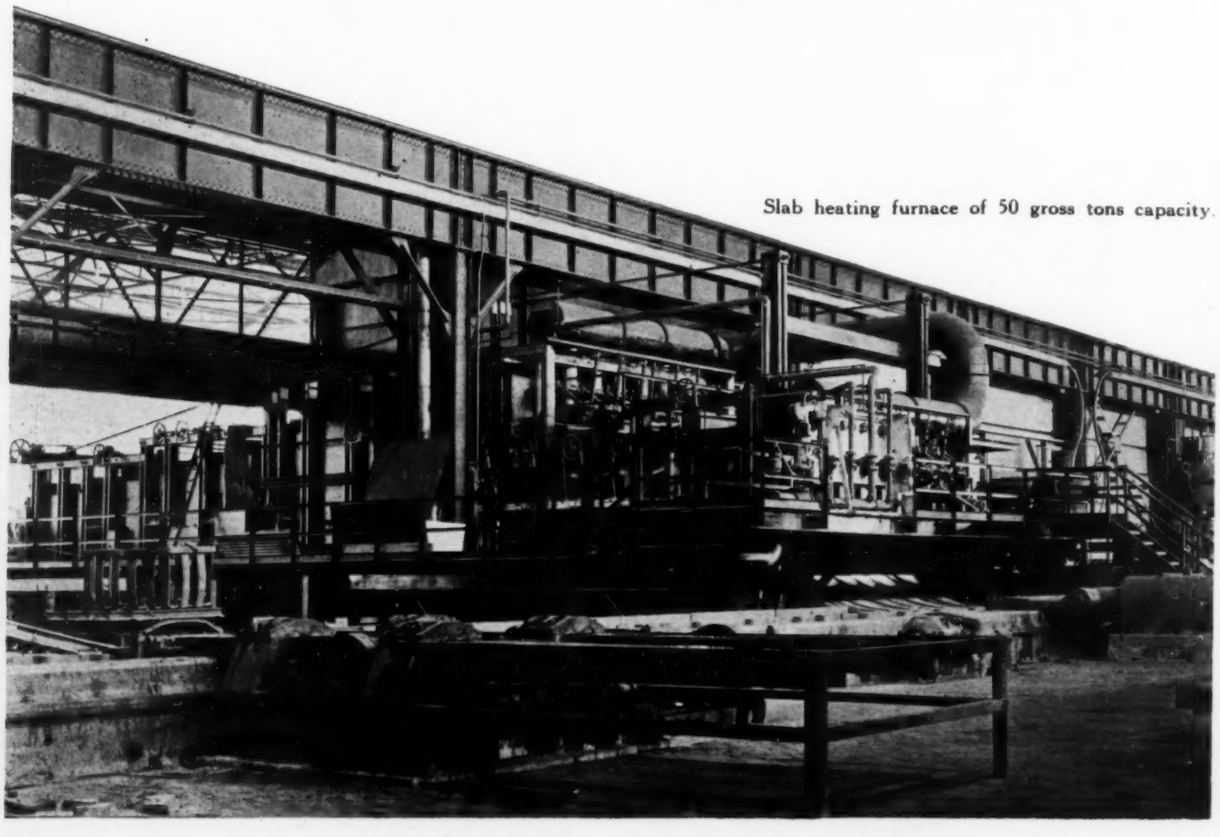
▲ FOR the past several years a serious discussion has been going on among the officials of the Granite City Steel Company as to what method or methods to take to meet competition from the strip mills that were being installed throughout the country.

Strip mills are fundamentally quantity production units and with the capacity of Granite City Steel Company at 30,000 tons per month it did not seem feasible or desirable from an economical standpoint to spend the several millions required for the conventional strip mill as well as bloomer in which to make slabs to satisfy the appetite of such an installation.

It was finally agreed to install such equipment as would satisfactorily meet the standards of strip production in every respect except that high tonnages were not considered.

The equipment and arrangement finally decided upon is shown diagrammatically on Pages 40 and 41, detailed description of which follows.

For producing slabs from ingots, the roughing mill of the former plate mill was used and a turn-table for use in spreading ingots to obtain wide slabs; a vertical edger; an up-cut slab shear, and conveying tables were purchased. The slabbing mill is a two-high unit 30″ x 100″, driven by a twin 36 x 48 horizontal reversing steam engine. About thirty feet from this mill is located a reversible vertical edger driven by a 1000 HP D.C. motor. The slab shear is of the up-cut design, 900 tons capacity and steam-hydraulically operated. From this shear the slabs may travel directly to the continuous mill or be conveyed at right angles on a United-Palmer Bee chain conveyor into the slab yard for stock or reheating in the slab furnace.



Slab heating furnace of 50 gross tons capacity.

Roughing scale breaker and three-high rougher.

Plans are made for the installation of two 50-gross ton continuous type slab reheating furnaces, but so far only one has been installed. This furnace is triple-fired with natural gas; 18 x 70 feet inside dimensions, equipped with Chapman-Stein tile recuperator. The furnace draft is automatically controlled by Leeds & Northrup equipment.

The rolling installation consists of a two-high roughing scale breaker; a three-high roughing mill with attached vertical edger; a two-high finishing scale breaker, and four 4-highs.

The roughing scale breaker is 30″ x 100″, with Ryertex water-cooled bearings, and driven by a 750 HP A.C. motor. On the delivery side is installed a 1000-pound hydraulic spray to remove furnace scale.

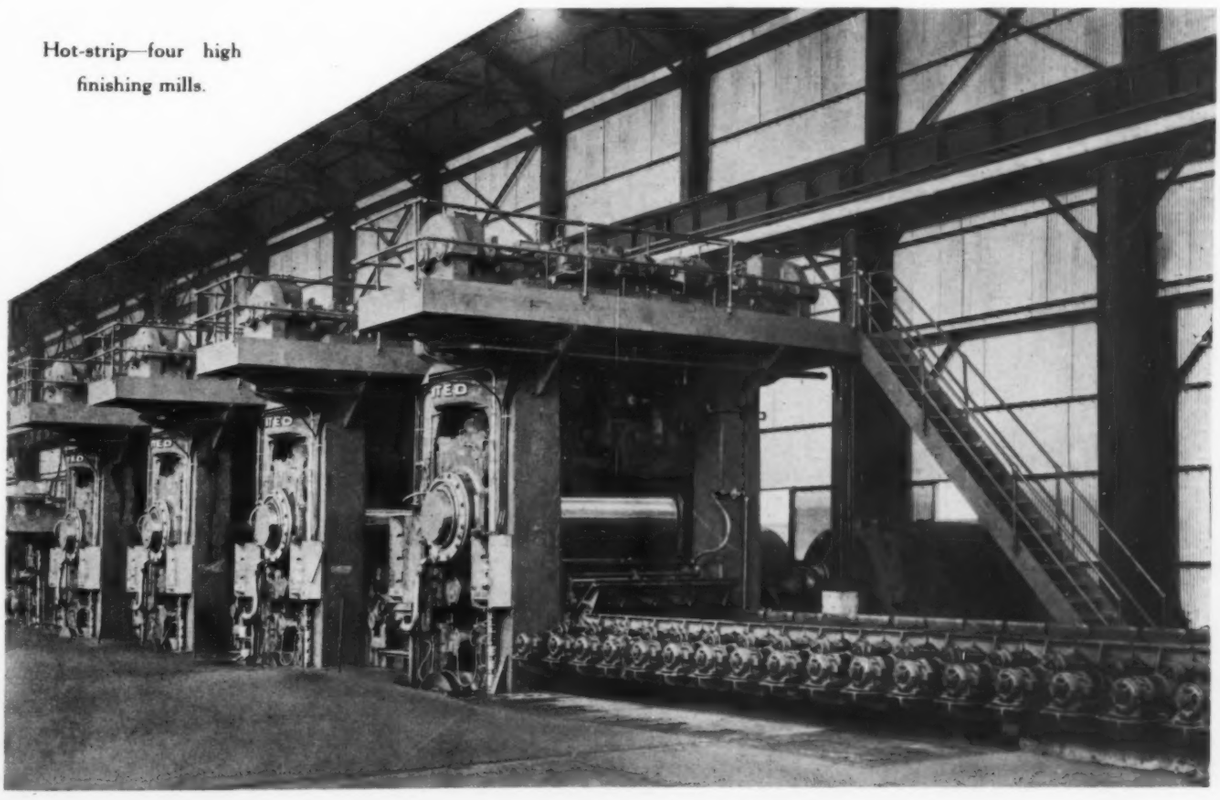
The 3-high roughing mill was used formerly as a plate mill. The only change that was made for its new purpose was to install Ryertex bearings and to add a vertical edger, which is driven from the Kennedy drive of the main mill. This unit is powered by a 3000 HP Westinghouse motor. It is evident, of course, that this single stand does the equivalent work of the four roughing mills of the conventional ten-stand continuous mill.

The finishing scale breaker is a 2-high unit 27″ x 90″ with Ryertex bearings, and is driven by a 350 HP D.C. motor.

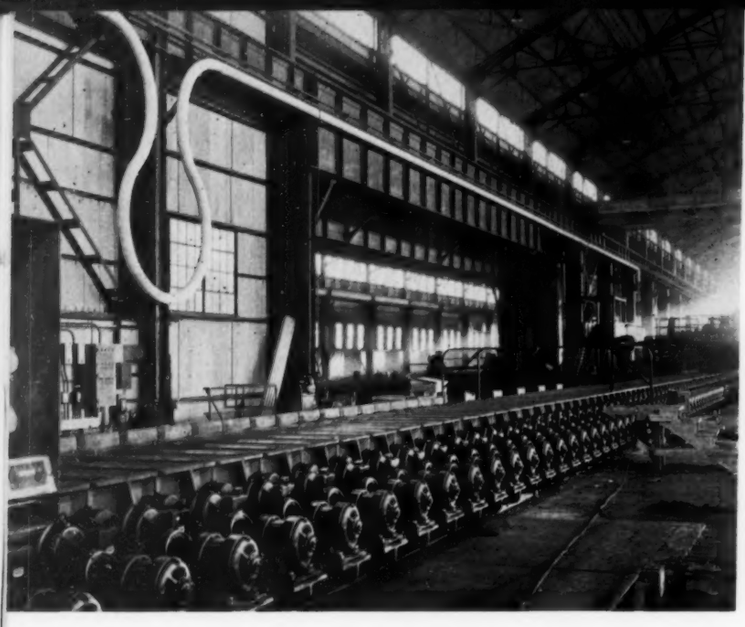
Of the 4-high mills, the first three stands are driven by 3500 HP D.C. motors while the fourth and last stand is driven by a 2500 HP D.C. motor. The work rolls are 26″ diameter with back-up rolls of 53″. The body length of each roll is 90″. Messinger bearings are used on the necks of the work rolls, lubrication being supplied automatically by a Farvel system. A DeLaval circulating oil system is used for the lubrication of the Morgoil bearings of the back-up rolls. Selsyn indicators are used on all guides and screwdowns.

Descaling sprays are located at the 2-high slab mill, roughing scale breaker, 3-high mill, and the finishing scale breaker. 1000-pound hydraulic water for the cleansing of scale is supplied from two—Allis-Chalmers centrifugal pumps with water bottles.

The three forms of products of this installation are, of course, plates, coils and flat sheets. Plates are carried by a chain transfer into a parallel building for



Hot-strip—four high finishing mills.

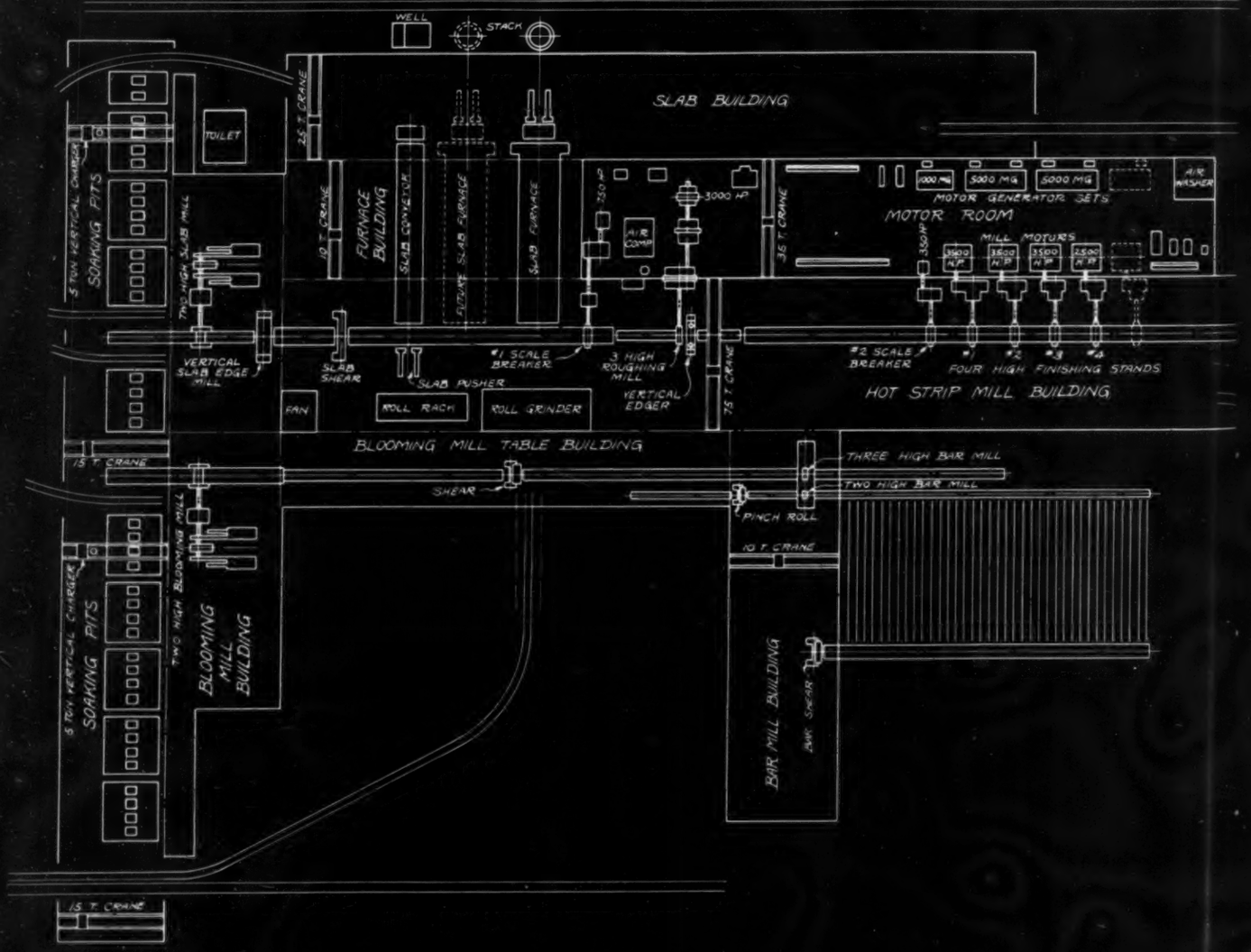


Hot strip runout table.

levelling and shearing to proper size. An upcoiler located about 200 feet distant from the last finishing stand receives the strip from where it is conveyed across a scale for weighing and then loaded into cars, either for breakdowns for the old style conventional 2-high hot mills, or to the cold-reducing mill. Sheets are cut to length and piled by a flying shear located in this same line immediately after the up-coiler.

Coils made on the hot strip mill for further reduction on the cold mill are transferred by railroad car to another part of the plant where are located the coil pickler, cold mill, shears, etc. The pickler is the new United type where the loose wound coils are rotated on a mandrel in the acid tank while the liquid itself is agitated by a motor driven propeller, with a flow at right angles to the rotation of the coil.

The cold strip mill is of the 4-high reversing type, United design, with a size of 16″ x 49″ x 48″. The work rolls are driven through Falk reducers by a 1250 HP D.C. motor with a 600 HP motor on each tension reel. After cold reduction the material is side trimmed,



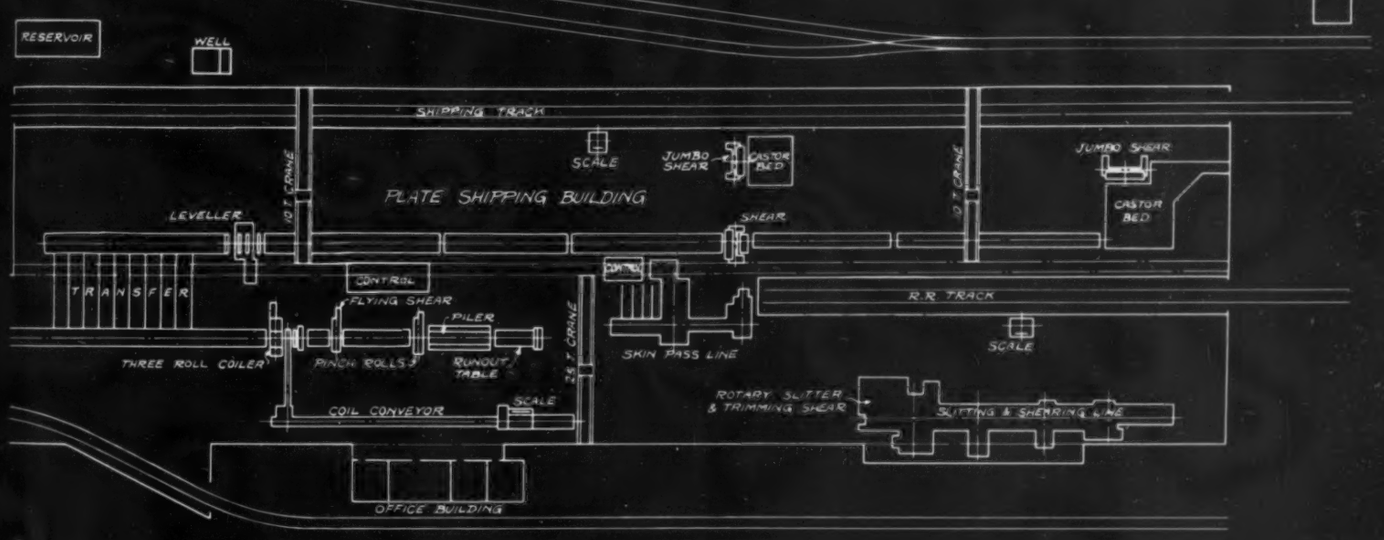
cut to length on a flying shear, and transferred to the annealing department.

All major mill equipment for both Hot and Cold Mills was supplied by United Engineering & Foundry Company. The Allis-Chalmers Manufacturing Company supplied most of the electrical equipment.

Four new overhead electric cranes were purchased from Harnischfeger Corporation, equipped with Cutler-Hammer magnetic controls. In the Hot Mill were installed: 1—75 ton—25 ton crane, and 1—25 ton crane, each with 50 foot span; and 1—25 ton, 50 foot span crane in the Slab Yard. In the Cold Mill 1—50 ton—10 ton crane with 75 foot span was installed.

With the increased power requirements it was found necessary to install two additional 7500 KW Allis-Chalmers turbo-generators using steam at 400 pounds, 640° F. at the throttle, with a take-off at the 160 pound stage for a reciprocating mill engine. For condensing the exhaust steam from these units, a Marley cooling tower of a capacity of 22,600 pounds per minute through a 15° cooling range was installed.

Four high reversing cold mill.



PLAN VIEW-90" HOT STRIP MILL

GRANITE CITY STEEL CO.-GRANITE CITY, ILL.

90" Semi-continuous 4-High Hot Strip Mill

GRANITE CITY

Rotary Coil Pickler

Drum Type Hot
Flying Shear
48" 4-High Cold Reduction Reversing Mill
STEEL COMPANY MILLS
Designed and built
by
UNITED
ENGINEERING and FOUNDRY COMPANY
PITTSBURGH — PENNSYLVANIA
All Rolling Mill, Pickling and
Shearing equipment designed
and built complete by United.
Tin Plate
Shearing Line
Associated Companies: DAVY and UNITED ENGINEERING CO., LTD. London, England; DOMINION ENGINEERING WORKS, LTD., Montreal, P.Q.

NEW TORCH GEAR-HARDENING MACHINE

▲ A NEW torch gear-hardening machine that does four times as much work in a given time as the ordinary gear-hardener has recently been perfected and patented by Farrel-Birmingham Company, Inc. of Buffalo, N. Y. It not only saves time and labor but reduces gas consumption and offers such fine adjustments of burners and water jets that the desired depth and uniformity of hardness are exactly secured.

While specially designed to harden double helical or herringbone gear teeth, this new machine is equally efficient for hardening single helical or straight-tooth gears, splines of rolling mill wabblers, sprocket wheels and similar parts.

It has two separate torch heads, and each head carries two sets of torches or tips. Therefore, both sides of the gear tooth and both helices of a double helical gear are hardened simultaneously. This is a great advance in efficiency over the single-head type of torch, for the latter hardens only one side of the tooth, doing only one quarter as much work in the same time.

In hardening double helical gears one torch head of the machine starts hardening at one end of the tooth while the other torch head begins at the other end. They travel toward the center or apex of the gear tooth on a horizontal traverse, but an ingenious device allows the torches to practically follow the helical trace of the teeth. This device is a guide roller on the torch carrier which engages the gear being hardened between two teeth and thus revolves the gear in correct relationship to the horizontal traverse of the torches.

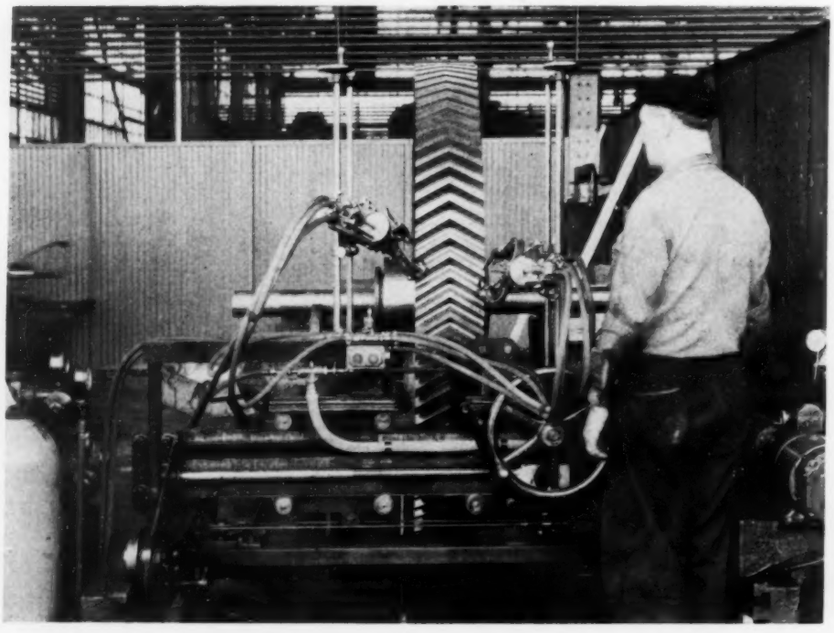
The traveling speed of the torches and attached water jets is regulated by a variable speed gear. It is generally from 6″ to 10″ per minute according to the tooth size.

A single lever controls the pilot lights for igniting the torches and their gas supply. Water pressure from a 250-gallon tank is kept constant and at correct volume by a centrifugal motor-driven pump equipped with a relief valve and other necessary fittings. This overcomes the difficulty of variable water pressure commonly encountered in most cities.

To enable the machine to handle any range of work quickly adjustable burners of seven different sizes are supplied.

Complete data on the new Farrel-Birmingham Gear Hardener will be furnished on request by Farrel-Birmingham Company, Inc., Buffalo, N. Y.

Torch gear-hardening machine specially designed to harden double helical or herringbone gear teeth.



NEW TYPE ELECTRIC FLOW-METER

▲ A NEW electrically-operated flow meter known as the Synchro-Meter has been developed by Bailey Meter Company, Cleveland, Ohio.

Basically, the synchro-meter consists of a transmitting unit, Fig. 1, which is operated by a Lædoux bell flow measuring mechanism of the type used in standard Bailey mechanically-operated fluid meters, and a receiver, Fig. 2, consisting of the indicating, recording and integrating instruments. The transmitter is located at the point of measurement of the variable and the receiver is located at a place or places convenient for obtaining readings from the instruments as frequently as desired.

A number of distinct advantages characterize the synchro-meter. For example, the transmitter places only a negligible retarding force on the measuring device. Furthermore, the torque developed to operate the receiving element is very large and does not send any reaction back to the transmitter. No adjustments of the synchro-meter are necessary at the transmitting end. It may, therefore, be located in a relatively inaccessible place. Several receivers may be operated from one transmitter.

Calibration of the synchro-meter transmitting system is simple and

Figure 1—Transmitting unit.

Figure 2—The receiver. This contains the indicating recording and integrating instruments.

permanent. Two scales, one on the transmitter and the other on the receiver, make it possible to test the transmitting system without calibrating the flow measuring element and conversely, to calibrate the flow measuring element without using the electrical system. In the former test, readings at the transmitter and at the receiver are compared, while in the latter readings are taken directly at the transmitter by means of the indicating pointer provided for that purpose.

Three wires are required to connect the transmitter to the receiver. With the use of No. 12 wire the transmitter may be located approximately one mile from the receiver. If larger wire is used, a greater distance is allowable providing the loop resistance does not exceed 20 ohms. Bailey synchro-meters require the use of alternating current at from 95 to 125 volts, and at a frequency of 25, 50 or 60 cycles.

As shown diagrammatically in the wiring diagram, Fig. 3, the Bailey synchro-meter transmitter consists essentially of the mechanically-operated measuring device, or meter; two contact arms swinging about points M and C; and a constant speed cam arranged to swing the lower contact arm in a continuous reciprocating cycle. The upper arm is positioned by the flow measuring device through the mechanical stop HT.

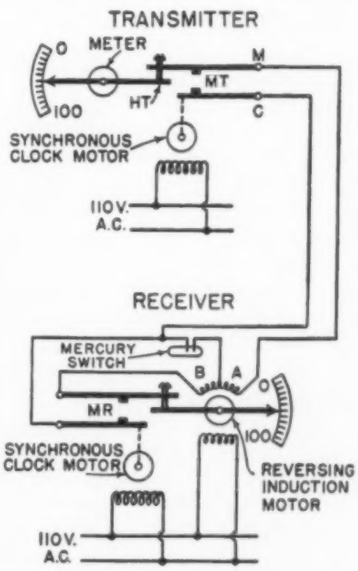
The indicating, recording and or integrating flow meter receiver operates in a similar manner except that in this case the upper contact arm is positioned by the reversing induction motor.

The lower arms in both the transmitter and receiver are caused to rise and fall by means of the identical cams driven by synchronous clock motors.

An induction motor provided with shading coils A and B is the means employed to position the receiver. Short-circuiting one coil produces rotation in one direction, whereas short-circuiting the other coil causes rotation in the other direction. If both coils are short-circuited or open-circuited simultaneously, no rotation results.

It will be noted that contacts MT in the transmitter are connected to short-circuit shading coil A when the mercury switch is closed, whereas contacts MR in the receiver are connected to short-circuit coil B. If contacts MT and MR close simultaneously no rotation in the reversing motor will take place. This means that the transmitter and receiver are in exact relation with each other.

Figure 3—Diagrammatic sketch of the transmitter.



If the rae of flow decreases contacts MT will be closer together than contacts MR and will close first, short-circuiting coil A, causing counter clockwise rotation of the reversing induction motor until the receiver reads the same as the transmitter. Likewise, if the rate of flow increases, the contacts MT will be farther apart and contacts MR will close first, short-circuiting coil B, causing rotation of the motor in the receiver in a clockwise direction to show a correspondingly higher meter reading.

The mercury switch, shown in the common line and installed in the receiver synchro-meter unit, is closed during the positioning cycle, but is open during the rest of the cycle. Opening of the mercury switch takes place before contacts MT and MR open on the down strokes of the roller arms, thereby preventing arcing or burning upon opening the contacts. In other words, contacts MT and MR close the shading coil circuits but never open them. This results in the maintenance of contacts in first-class condition at all times.

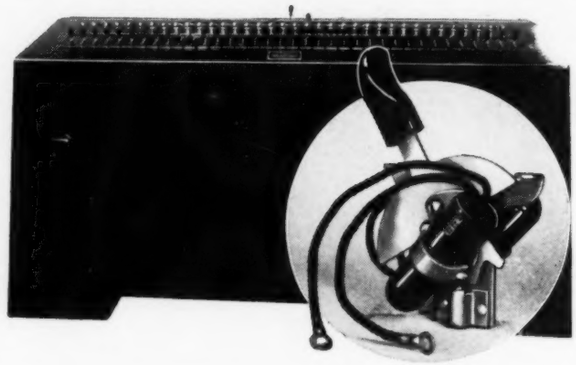
In case of power failure, provision is made for automatically reestablishing the proper phase relation between the transmitter cam and the receiver cam so that the synchrometer remains accurate under all conditions.

DEVICE SIMPLIFIES REMOTE CONTROL

▲ REMOTE control of electrical circuits is simplified by a recent development of the Jefferson Electric Company which provides a universal control switch mechanism. Designed for mounting to the rear of a panel with only the switch handle protruding it serves to give finger tip, master control over motor circuit contactors, safety and limit switches.

One or more non-breakable metal mercury tubes are clamped in screw down clips, selectively yet permanently positioned. Each tube will make and break a circuit of 15 amperes and 125 volt AC rating without exposed arcing through countless cycles. Comparative ratings on higher voltages either AC or DC render the tubes readily adaptable to commercial circuit requirements.

Two switch movements are available—"off—on" and "center return". An adjustable sector permits mounting to a vertical, horizontal or angular positioned panel.



Universal control switch mechanism.

The illustration shows an installation, in one bank, of thirty seven of the switches for remotely controlling motor circuits in a mine. Quiet, sure control is concentrated within arms length. These control switches and mercury tubes are manufactured by Jefferson Electric Company, Bellwood (Suburb of Chicago), Illinois.

DEVELOPMENT FOR OIL FLOW MEASUREMENT

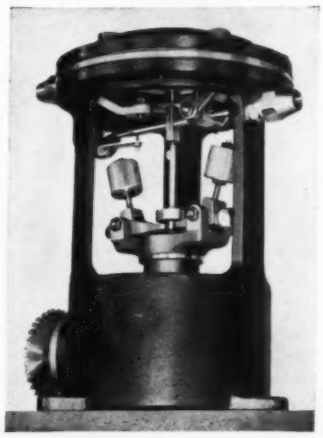
▲ A NEW development for oil flow measurement usable for control purposes has recently been announced by the Askania Regulator Co. of Chicago, Illinois. The manufacturer claims that the "Askania Oil Transometer, due to the inherent qualities existing in its design, eliminates all errors in oil flow measurement due to changes in viscosity, temperature and specific gravity.

The illustration shows the Askania Transometer with the protecting cover removed. The sprocket shown is driven by a chain from a positive displacement meter. As the speed of the sprocket increases or decreases, caused by varying oil flow, the fly-ball governor will rise or fall in proportion to the variation in oil flow.

The vertical force of the fly-ball governor is transmitted to the Askania jet pipe into which air is introduced through the right hand inlet. Air leaving the jet pipe enters a receiving nozzle which is connected to the top of the diaphragm.

As the air pressure on the diaphragm depends upon the position of the jet pipe, the more the jet pipe registers with the receiving nozzle, the greater will be the air pressure on the diaphragm. The position of the jet pipe will always be such that the air pressure on the diaphragm balances the centrifugal force of the governor.

Thus the air pressure created by the governor is in direct proportion to the centrifugal force of the governor, and therefore, a square function of the oil flow through the meter.



Oil Transometer for oil flow measurement.

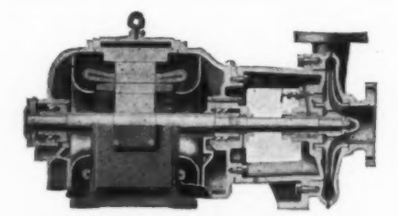
Slight pressure changes of the air entering the jet pipe do not affect the accuracy of the instrument since the jet pipe always and automatically finds a position in which the air pressure on the diaphragm balances the upper force of the governor. The air pressure created is an accurate measure of the air flow and may be

used with Askania control equipment as a metering impulse in connection with any oil flow problem.

Complete data may be secured by writing to the manufacturer.

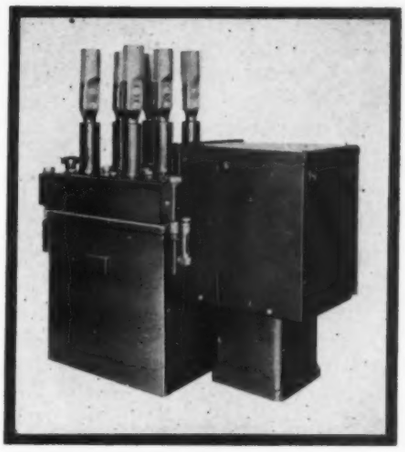
MOTOR-DRIVEN CENTRIFUGAL PUMPS

▲ A NEW line of motor driven centrifugal pumps for capacities of from 5 to 1200 gallons per minute and heads of 10 to 230 feet is announced by the De Laval Steam Turbine Co., Trenton, N. J. The pump is mounted upon the end bell of an electric motor, the two forming a compact and self-contained unit, with only one shaft and two bearings. A motor-mounted pump is shipped ready for immediate connection to piping and power supply line and can be installed with the shaft horizontal, vertical, or inclined, or the unit can be mounted upon a hand truck or suspended from a sling. The pump is suitable for handling cold or hot water, brine, chemical



Motor driven centrifugal pump.

solutions, extracts, juices, liquors, oil and gasoline, etc., in buildings and in various industrial and process plants. The pump casing is of cast iron, while the impeller, wearing ring, shaft sleeve, stuffing box gland and lantern ring are of bronze. Special materials can be supplied where required. All parts subject to wear are made to limit gages, so that they are interchangeable, and replacements ordered from the factory can be inserted without having to be fitted. All pump parts can be removed without disturbing the motor.



NEW OIL BLAST CIRCUIT BREAKER

▲ A NEW oil blast circuit breaker, the Type FK-45, with 75,000 kv-a interrupting rating has been announced by the General Electric Company. (Illustrated above).

The FK-45 unit is a non-oil-throwing breaker with plate steel rectangular tank with separating chamber, internal mechanism, silver-to-silver main contacts, easily renewable arcing contacts, oil blast baffles, and Kerkolite bushings. It is available in three current sizes, 600, 1200 and 2000 amperes.

A feature of the new breaker is its sturdy tank construction which makes it especially applicable where heavy duty and small space requirements are desired. The silver-to-silver main contacts and easily renewable butt-type arcing contacts with their massive and unusually strong construction make this breaker applicable for the hardest type of service. A noteworthy feature of the arcing contacts is the unit assembly of the stationary contacts with block and springs. This design aids in quick replacement with very little labor and lost time involved.

The new breaker ratings, in accordance with NEMA standards, are as follows:

Volts	Amperes	KV-A Interrupting	Max. R.M.S. Int. Amperes
15,000	600	75000	25000
7,500	1200	75000	25000
5,000	2000	75000	25000

NEW BOOKLETS AND CATALOGS

▲ WESTINGHOUSE engine driven welders, single operator, 200-300-400 amperes sets are described in a recent publication which includes performance curves of the welder, fuel consumption curves of the engines and general descriptions of the welders and power units. Copies of the publication are available from the nearest district office or direct from Department 5-N, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania.

▲ JUST off the press is the 1937 standard catalog on New Departure Ball Bearings. In addition to the up-to-date listing of all available types, sizes and list prices are interesting sections on Bearing Selection, Mounting Directions, Fits and Tolerances, Equivalent Bearing Tables and Telegraphic Code.

Catalog is 146 pages, Wire-O bound, with tabs at each section for easy reference. Ask for Booklet "S".

New Departure Division General Motors Corp., Bristol, Conn.

▲ A NEW catalog just issued by Combustion Engineering Company, Inc., New York, describes its Type VU Steam Generator which is of standard construction, complete in sizes ranging from 15,000 to 250,000 pounds of steam per hour and for any steam pressure up to 1000 pounds per sq. in. This is a two-drum unit, fired with pulverized coal, oil or gas, the burners being located in the front of the furnace with tangential admission of secondary air. The design is symmetrical in that any section taken through the unit from front to rear is similar to any other section so taken and the gases enter the tube bank at a practically constant temperature across the entire width of the unit. The setting is steel-encased.

The catalog is fully illustrated with both exterior and cut-away views of the unit, line drawings and detailed sectional views of the burners; also details of the furnace wall construction, mills, etc., as well as descriptive matter and data.

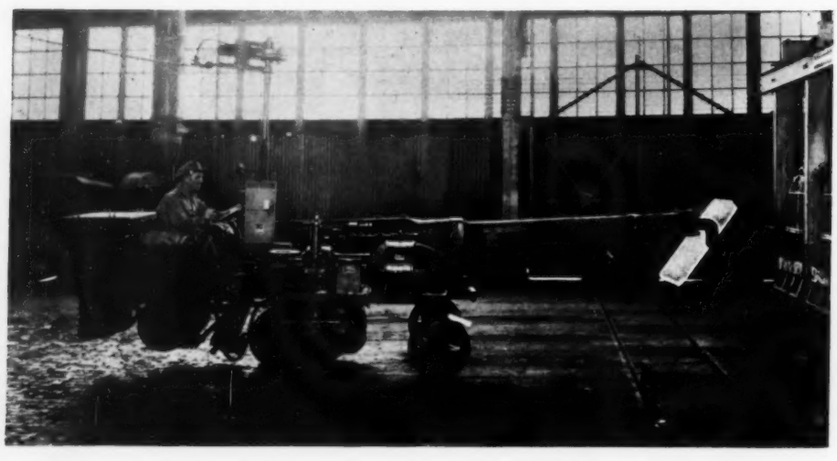
CHARGING DEVICE FOR OPEN HEARTHS

▲ TO meet the demand of the efficient charging equipment for the smaller open hearth and heating furnaces, where the expense of installing the usual floor type of machine would be prohibitive, there has been developed a comparatively inexpensive charging device called an Auto Floor Charging Machine by Edgar E. Brosius, Inc., Sharpsburg, Pa. This is a compact, self contained unit, mounted on three rubber tired wheels and driven by an electric motor. The tilting of the peel, the operation of the tongs or, in the case of melting furnaces, the rotation of the charging box are accomplished by means of oil cylinders actuated by an oil pump direct driven by an electric motor. The three wheel arrangement provides a very flexible machine, particularly adapted to operation in congested areas as the machine can be rotated on its own wheel base. Its movement is not restricted to any definite path and when not in use can be run out of the way, leaving the charging floor free from obstruction. There are no tracks obstructing the charging floor and no need for expensive overhead runways.

The auto charger was originally developed a number of years ago for serving a heating furnace and handling bundles from the furnace to a mill. It had a capacity of 4000 pounds and proved so successful that it has constantly been modified to suit various special requirements, and its capacity increased until now one of these machines is serving double row heating furnaces, handling up to 10,000 pound blooms in and out of the furnaces and to and from the roller table of a roughing mill. It is also being used for turning the blooms in the furnace. The larger machines are provided with a hydraulically operated steering mechanism so that the operator steers the machine by merely operating a small valve.

The machine as illustrated is for handling 8″ x 8″ billets weighing 2000 pounds.

Auto floor charging machine capable of handling billets weighing 2000 pounds.



ROLL CORPORATION WILL MODERNIZE

▲ THE PITTSBURGH Rolls Corporation, a Blaw-Knox Company subsidiary and a large manufacturer of rolls, is modernizing and expanding its equipment. Three air melting furnaces, formerly hand fired with coal, or oil fired, are being equipped with a modern pulverized coal burning system. In conjunction with the pulverized coal machinery, there is to be installed a complete coal handling system, permitting the unloading of coal from hopper cars, conveyance to elevators, and then to the pulverizers, entirely by mechanical means. Worthwhile economies in fuel, fuel handling, and melting costs will be realized.

Naturally power demands will be increased greatly, and, to provide greater horse power capacity, an electrical 22 K.V. loop station is being erected. This is the latest type transformer station designed to minimize the possibility of power shut-offs.

Additional equipment also will include two new roll grinders of their own design, and a 1,300 cubic foot air compressor. Added to an original six, these new roll grinders will give the mill a range in these machines of from 20 to 60 inches.

BOOK SUMMARIZES CONVEYER EQUIPMENT

▲ A BOOK containing over 100-pages, summarizing processing equipment installed by the Mathews Conveyer Company during the past eighteen months. This book is divided into six sections: Introductory,

coil handling, conveyers, sheet processing, and a section dealing with roller conveyers and wheel conveyers, all designed primarily for equipping the steel industry for continuous production.

TWO THREE-HIGH ROUGHERS ORDERED

▲ LEWIS Foundry & Machine Company, a subsidiary of Blaw-Knox Company has received a contract from Tennessee Coal, Iron and Railroad Company for two three-high roughing mills, complete with Lewis roller and catcher tables, for installation at their sheet mills at Fairfield, Alabama.

NEW TYPE RECORDER IS DEVELOPED

▲ THE C. J. Tagliabue Mfg. Co., has just announced a new recorder called the Celectray. In this radically new type of recorder, a sensitive mirror galvanometer is the primary controlling element in which an inortialess beam of light takes the place of the customary metal boom or pointer. The beam of light from the galvanometer in moving on and off a phototube passes the "controlling edge" of a screen thus operating relays which in turn control a reversing motor which drives the moving contact of the Wheatstone bridge or potentiometer. The phototube is not a calibrated element but serves only to detect the direction of the light-beam and bring the galvanometer to zero deflection, according to the well-known null method of balancing an electric circuit. The new instrument, therefore, is not a "photo-electric potentiometer" in the sense that a balance of photoelectric current is implied.

It is evident that the galvanometer is free at all times from mechanical engagement, and this fact, together with its low moment of inertia, permits rapid balancing and control actions. Furthermore, a high current sensitivity is available, permitting the use of high resistance, or of very long thermocouple leads without material loss of accuracy in the balancing. Or, on occasion, a very low scale range does not require the use of a very low resistance and its resultant disadvantages.

It is claimed that the new instrument is noteworthy for its extreme simplicity, accuracy and speed, particularly in the multiple point recorders. The average speed of the multiple point instrument is less than 15 seconds per point and the accuracy is guaranteed to 0.1%.

In the Celectray the problem of stopping a moving light-beam on the edge of a photoelectric cell with speed and precision has been solved for the first time. This solution has resulted in the elimination of many parts from the previous models and has increased the available speed of recording. Numerous kinds of recorder-controllers, recorders and indicating controllers or resistance thermometers, as well as thermocouples and other electrical devices, are available.

WELDING BULLETIN

▲ "THE Arc-Welding of Tomorrow" is the title of the Smootharc Welder bulletin recently released by the Harnischfeger Corporation of Milwaukee. As modern in presentation as the subject it deals with, this book, No. W10, puts "in black and white" the advantages gained by the internally stabilized arc. It tells just what single current control means to the operator—what improvement it makes on the finished welded product. Clear action photos illustrate all the uses of many of the many Smootharc models—from the vertical 75 and 100 ampere types to the 200, 300, 400 and 600 ampere horizontal models. Stationary and portable-trailer Smootharcs are also shown. It explains the importance of the arc characteristic to modern welding practice. A cut-away view is used to tell the story of Smootharc design. This bulletin may be obtained by writing the Harnischfeger Corporation, 4200 West National Avenue, Milwaukee, Wisc.

Republic Steel Corp. officials welcomed the country's leading agricultural engineers, farm and trade paper editors at the formal opening of the corporation's new wire mill in South Chicago April 27. J. L. Hyland, Chicago district manager of Republic, right, was host for the occasion. Shown with him are, left to right, E. M. Richards, assistant to the vice president in charge of operations; N. J. Clarke, vice president in charge of sales; T. M. Girdler, chairman; C. M. White, vice president in charge of operations; and R. J. Wysor, president. The corporation announced establishment of a fellowship in agricultural engineering at Iowa State College, Ames, Ia., to encourage the more intelligent application of steel on the farm.

ITEMS OF INTEREST

E. S. Harman has been appointed superintendent of the rail mill at the Gary Works of the Carnegie-Illinois Steel Corporation.

Mr. Harman is a graduate of Armour Institute with a degree in Mechanical Engineering, class of 1915. While attending school he worked as a first helper on an open hearth furnace. Previous to joining Carnegie-Illinois, largest United States Steel subsidiary, Mr. Harman gained steel industry experience as an assistant to master mechanic, assistant to chief engineer, steam engineer and superintendent of steam power. From 1924 to 1933 he headed his own business as consulting engineer and consulting engineer and construction engineer.

Mr. Harman came to the South Works of Carnegie-Illinois in 1935 as a fuel engineer. In 1936 he was appointed to the position of assistant division superintendent of rolling at South Works.

▲

Thomas R. Owens has been appointed superintendent of the Gary Sheet mills of the Carnegie-Illinois Steel Corporation, succeeding A. J. Skemp, who died April 5. Phillip H. Dilley, who had been turn foreman in the hot sheet mill, succeeded Mr. Owens as night superintendent, and Showers Mason was appointed turn foreman.

Mr. Owens first became connected with United States Steel Corporation subsidiaries in 1908, when he was employed at Old Meadow works of the former American Sheet and Tin Plate Company at Scottdale, Pennsylvania. He worked there as a catcher until 1913, when he left the company for three years, returning in 1916 when he was employed at the Gary sheet mill. He has remained in the hot mill department at Gary until the present time, his most recent position being night superintendent of the hot sheet mills.

R. F. Campbell has been appointed division superintendent, Division of Open Hearths and Central Mills, Carnegie-Illinois Steel Corporation, Gary, Ind.

Mr. Campbell came to Gary from the Clairton, Pennsylvania, plant of the Carnegie Steel Company in February 1907, starting as general foreman in the yard department. In March 1910, he was appointed assistant superintendent of the number four open hearth, becoming superintendent of the department in March 1912. Since April 1930 he has served as superintendent of all open hearth furnaces at Gary.

▲

R. B. Hancock has been appointed division superintendent, division of west mill, including all merchant mills, the 38-inch hot strip mills, wheel and axle mills, Carnegie-Illinois Steel Corporation, Gary, Ind.

Mr. Hancock has been connected with Gary works since May, 1909, when he came there from Buffalo, New York, and began work as a rail mill roller. He was made assistant superintendent of the merchant mill in 1914, and superintendent of the merchant mill and wheel mill in March, 1918. He was appointed superintendent of the merchant mill, wheel mill and axle mill in September, 1925.

▲

Frank Mooney has been appointed superintendent of No. 2 open hearth plant, Gary works, Carnegie-Illinois Steel Corporation. The furnace has been down since October 1930. Preliminary to starting production in the furnace, the corporation plans to blow in the No. 4 blast furnace at Gary about April 10.

Mr. Mooney came to Carnegie-Illinois, largest United States Steel Corporation subsidiary, from Lackawanna, N. Y., in February of 1924. Beginning as a handy man in the open hearth department he was promoted to cinder pit man, labor foreman,

E. S. HARMAN

THOMAS R. OWENS

R. F. CAMPBELL

R. B. HANCOCK

FRANK MOONEY

GEORGE T. GRIFFITHS

general foreman and assistant superintendent. In March 1936, he went to South works of the corporation as assistant superintendent of the Bessemer and No. 3 open hearth plant. He is a graduate of the University of Minnesota.

▲

George T. Griffiths has been appointed assistant general superintendent of the Clairton Steel Works and Furnaces, in charge of River Transportation of the Carnegie-Illinois Steel Corporation.

Mr. Griffiths succeeds the late Harry F. Shaw as head of the Company's Marine Ways and Inland Waterways fleet.

Mr. Griffiths came to the company early this year as superintendent of steamers and landings. Prior to that time he had spent almost six years as assistant hull inspector of the Government steamboat inspection service. From 1919 to 1931, he had served as mate, pilot, and captain with the Carnegie Steel Company. He began his career in 1911, as a deckhand on the Steamer Monitor. During the World War he spent 17 months in the Army Engineers Corps.

▲

Robert Stoker, formerly superintendent of galvanizing department, Vandergrift works of the Carnegie-Illinois Steel Corporation, has been appointed to a newly created advisory position in the sheet and strip division of the metallurgical department.

Long recognized as an expert on steel galvanizing and pickling, Mr. Stoker's new duties will be to analyze the problems and requirements of the trade in all sales districts of the company.

Mr. Stoker, now in his thirty-seventh year with United States Steel Corporation subsidiaries, had been superintendent of the galvanizing department at Vandergrift Works from 1916 until the present appointment. He assumed his new duties on April 15.

▲

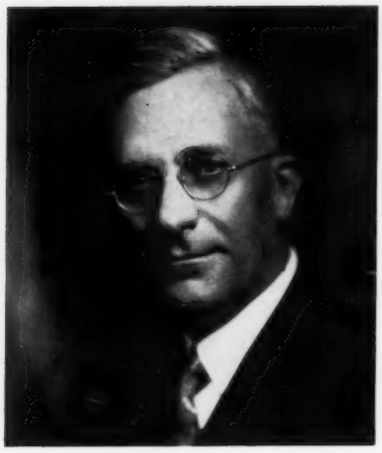
L. F. Burress has been appointed division superintendent, Division of Coke Plants and Blast Furnaces, Carnegie-Illinois Steel Corporation, Gary, Ind.

Mr. Burress came to Gary works in August 1911, from the University of Missouri, starting as heater helper in the coke plant. In 1912 he was made cooler house foreman. He was appointed superintendent of the by-product department in 1914, and a year later became assistant superintendent of the coke plant. In 1916 he was named as superintendent of the coke plant, remaining in this position until 1935, when he was appointed assistant superintendent of Gary works.

ROBERT STOKER

L. F. BURRESS

W. T. HUGUS



CHARLES H. ELLIOTT

FRANK E. FLYNN

W. T. Hugus has been appointed superintendent of the American works of the Carnegie-Illinois Steel Corporation, Elwood, Indiana, succeeding John Byus, who is retiring.

Mr. Hugus has been connected with United States Steel corporation subsidiaries and their predecessors ever since he first began work. Starting as a clerical worker and hot mill catcher at the LaBelle Iron works, he went to the American Tin Plate company's Laughlin works in 1900 as assistant manager. Nine years later he became hot mill superintendent of the Chester, Pennsylvania works of the American Sheet and Tin Plate company. During the years from 1910 to 1925 he served successively as assistant manager of the Farrel works, manager of the Crescent works and later, manager of the Laughlin works. He came to the Gary Tin mill in 1925 as assistant manager. In 1935 he was transferred to the company's Pittsburgh office as assistant to vice president. When the American Sheet and Tin Plate company became a part of the Carnegie-Illinois Steel Corporation, Mr. Hugus was made assistant manager of industrial relations for the Pittsburgh district.

John Byus, the retiring superintendent, was born in Mason County, West Va., and spent his early days on a farm, later engaging in the lumber business. He bagan his work in the steel industry as a laborer at the plant of the Aetna Standard Iron and Steel Company of Bridgeport, Ohio in 1896. He later spent some two years in the Laughlin Nail Company at Martins Ferry, Ohio, and then returned to the Aetna company in 1898. In 1899 he returned to Martins Ferry, where the American Tin Plate Comwas then operating the Laughlin plant. After serving in various positions there he was appointed hot mill superintendent, and in 1909 was transferred to Shenango works of the American Sheet and Tin Plate Company at New Castle, Pennsylvania. There he served as hot mill foreman until 1911, when he was transferred to the Crescent works at Cleveland. In 1914 he returned to Martins Ferry as hot mill superintendent at Laughlin works, and in 1915 he came to Elwood as hot mill foreman. He was appointed manager of the American works at Elwood in 1920. He continued in this position after the plant had become a part of Carnegie-Illinois Steel Corporation, although the title has recently been changed to that of superintendent.

▲

Charles H. Elliott, manager of the Youngstown-Warren district, Republic Steel Corporation, Cleveland, has been promoted to assistant vice president in charge of operations. Mr. Elliott was assistant superintendent of blast furnace and steel plant, Youngstown Sheet & Tube Company, in 1911. In 1919 he was made manager of the steelworks, Weirton Steel Company, and in 1924 general superintendent, South Side plant Jones & Laughlin Steel Corporation. In 1926 he became vice president in charge of operations, Trumbull Steel Company at Warren, Ohio, and has been with Republic ever since the merger.

▲

Frank Edward Flynn, general superintendent of the Republic Steel Corporation, Warren District, will succeed Mr. C. H. Elliott as manager of the Warren-Niles district.

Mr. Flynn started in the steel business with the Superior Steel Company at Carnegie, progressing from the position of water boy to that of boss roller. In 1916 he started in charge of rolling at the Phillips Sheet and Tin Plate Company, which later became the Weirton Steel Company, and during his 11 years service there he became assistant manager and then manager. He came to the Trumbull Steel Company in 1928 as assistant vice president in charge of operations. This company later became a unit of Republic Steel Corporation, and he was made assistant district manager. When the general offices of Republic Steel Corporation were moved to Cleveland, he became general superintendent in charge of all operations, at the Warren Division, which is composed of the Warren, Niles, Trumbull-Cliffs, and Newton Falls Works.

R. G. Adair, who has been assistant to the works manager of the Butler Plant of The American Rolling Mill Company, has been appointed assistant director of Industrial and Public Relations for the company, with headquarters in Middletown, Ohio. Mr. Adair will assume his new responsibilities within a few weeks.

During his residence in Butler, Mr. Adair has taken a prominent part in community activities. He has served as president of the Butler Y. M. C. A., president of the Butler Chamber of Commerce, director of the Pennsylvania State Chamber of Commerce, director of the Pittsburgh Personnel Association, as well as serving as an officer in a number of other civic and state organizations. Mr. Adair is also a member of the Board of Directors of the Association of Iron and Steel Engineers.

Mr. Adair joined the Armco organization in 1916, as a laborer in the processing department of the Middletown works. On becoming a foreman he evidenced unusual interest and ability in safety work. This aptitude resulted in his appointment as plant safety engineer, and he later became supervisor of safety for all Armco plants. In 1929 he was given the responsibility of directing organization training in all plants of the company, in addition to his responsibilities for accident prevention.

▲

C. H. Hunt, consulting engineer, who has had wide experience in the steel industry, has opened an office at 1213 First National Bank building, Pittsburgh. In 1902 he started with the William Tod Co., Youngstown, O.; in 1903, was associated with the Morgan Engineering Co., Alliance, O., in the building of cranes and general rolling mill machinery; in 1908, joined the Buckeye Engine Co., Salem, O.; in 1909, went with Carnegie Steel Co., Youngstown, O., working on the early plans for the merchant mills which have since developed into the mills of Carnegie Steel Co., at McDonald, O.; in 1910, joined the organization of Youngstown Sheet & Tube Co., having charge of the design of their second blooming mill and arrangement of their new open hearth furnace plant; and returning in 1914 to William Tod Co. as chief engineer of the steel plant and blooming mill division.

In 1916 Mr. Hunt went with the Weirton Steel Co. as chief engineer of construction on their new strip mill development and was in charge of the design and construction of the first continuous hot strip mill installed by Weirton Steel. For sixteen years he was chief engineer of this company, in charge of design and construction of all plant developments. In 1932 he was appointed assistant to the president, in charge of design and construction of all projects of Weirton Steel Co. and consultant for National Steel Co. plants in Detroit and Buffalo.

Mr. Hunt is a very prominent active member of our Association having served on the board of directors and as treasurer of the society.

▲

W. Frank Detwiler, formerly executive vice president of the Allegheny Steel Company, was elected president of the company, succeeding the late Harry E. Sheldon.

Mr. Detwiler, the new president, started with the company in 1909 as a time-card employee on the night shift and rose rapidly to executive status. He became a plant manager in 1918, general manager in 1928, vice president in 1931 and executive vice president and a director of the company in 1934.

Prior to his connection with Allegheny Steel Company, Mr. Detwiler received apprentice training with Westinghouse Electric & Manufacturing Company at East Pittsburgh, Pennsylvania.

He is a director of the American Iron & Steel Institute and of the Pittsburgh Army Ordnance Association. Mr. Detwiler has long been an active member of the Association of Iron and Steel Engineers.

▲

T. P. Riley has been appointed superintendent of the personnel and employment for the new Irvine Works of the Carnegie-Illinois Steel Corporation, to be built in the vicinity of Clairton, Pa.

Mr. Riley began at the Gary sheet mill of the former American Sheet & Tin Plate Company as a laborer

R. G. ADAIR

C. H. HUNT

W. FRANK DETWILER

in 1911. Later he worked as a loader in the White Warehouse, as finishing department foreman and various jobs in the galvanizing department. After service as a lieutenant in the United States Army on the Mexican border and infantry Captain during the World War, he returned to the sheet mill in 1919 in the galvanizing department. Less than a year later, he became employment manager at the sheet mill, and in 1923 was made management representative for the mill. He became superintendent of industrial relations for the sheet and tin mills of the Chicago District in July 1936.

▲

Harry D. Robb, district manager of Timken Roller Bearing Company, Pittsburgh, Pa., has also been appointed district manager in charge of steel sales for

HARRY D. ROBB

the Steel and Tube Division of the Timken Roller Bearing Company. Mr. Robb, a graduate of Pennsylvania State University is a well-known figure in the iron and steel industry, and an associate member of the Association of Iron and Steel Engineers.

▲

James M. Hill has been elected president and general manager of Empire Sheet & Tin Plate Co., Mansfield, O. He was formerly vice president in charge of operations and general manager, coming to Empire last August. Hill has been identified with the steel industry for nearly twenty five years, resigning as assistant manager in the Canton-Massillon district of the Republic Steel Corp. to go to Mansfield. His earliest work and training in the Industry started with his employment with the Reeves Mfg. Co. of Dover, Ohio, in 1912. Leaving that plant in 1915, he became associated with the Seneca Iron & Steel Co. at Blasdell, N. Y., as assistant general superintendent of all operations. From that post he advanced to an executive position with the Hydraulic Pressed Steel Co., Cleveland, in 1917. While with this concern, he was superintendent of the Canton division and subsequently operated sheet and jobbing mills at Apollo, Pa. In 1922, Mr. Hill became identified with the Weirton Steel Co. and in August, 1927, was promoted to district manager in charge of the sheet and tin plate plants in Weirton-Steubenville-Clarksburg districts. He resigned his position with Weirton Steel to accept the post with Republic.

▲

Ralph R. Jenkins has been appointed assistant to the president of Empire Sheet & Tin Plate. His early work and training was with the Western Reserve Steel Co., located at Niles, O., and which company was absorbed by the Brier Hill Steel Co. Later, Mr. Jenkins left the employ of Brier Hill to become affiliated with the Falcon Steel Co., where he remained for nine years, after which time he came to Mansfield. Mr. Jenkins has been with Empire for approximately ten years in various capacities.

▲

William Lake has been appointed general superintendent of all plants of the Empire Sheet & Tin Plate Co. He was formerly connected with Follansbee Bros. Co., Follansbee, W. Va., having been employed at that plant for thirty-two years, and coming up through the ranks to the position of general superintendent in charge of operations. Approximately a year ago Mr. Lake left Follansbee to become associated with Empire.

▲

Chambers Andrew Patterson has been appointed Holophane Sales Engineer for the St. Louis—Kansas City territory. A native of St. Louis, Mr. Patterson brings to the territory a thorough knowledge of illuminating engineering gained by many years of experience in engineering capacities with several power companies. His most recent connection was with the Alabama Power Company, as commercial and industrial lighting engineer, from which he resigned to take over his new duties with the Holophane organization.

▲

George F. Walker, who has been connected with sales development at the H. H. Robertson Company, Pittsburgh, Pa., for approximately twenty years, has joined the sales staff of Mackintosh-Hemphill Company and will be interested chiefly in the furtherance of their steel casting division.

Mr. Walker has spent his entire life in the Pittsburgh District and served during the war in foreign service with the Chemical Warfare Division of the United States Army.

▲

Fred C. Kindler has been appointed manager of steel casting sales of Mackintosh-Hemphill Company, Pittsburgh, Pa. Mr. Kindler left a similar position with The Otis Steel Company, Cleveland, Ohio, with whom he was connected for approximately twenty-six years in the steel foundry department in various capacities.

▲

Thomas Chalmers, vice president in charge of manufacturing operations of the Tennessee Coal, Iron & Railroad Co., Birmingham, Ala., announces the following changes in personnel:

N. L. Van Tol, general superintendent of Ensley and Fairfield steel works, has been made works man-

ager in charge of all manufacturing operations of the company, with headquarters at the Fairfield steel works; J. M. Spearman, assistant general superintendent, Fairfield Steel works, has been made general superintendent of Fairfield steel works; E. C. Kain, assistant superintendent of the open hearth department of Ensley works, has been made assistant general superintendent of Fairfield steel works; C. R. Bottenfield, formerly employed as superintendent of the hot strip department of the Gary sheet and tin mill, has been appointed general superintendent of the Fairfield tin mills; A. H. Chalmers, superintendent, Fairfield coke works, becomes assistant general superintendent of Fairfield tin mills; J. J. Phillips, chief operator of Fairfield coke works, succeeds A. H. Chalmers as superintendent of Fairfield Coke works; Dudley Vaughan, assistant superintendent of the Fairfield open hearth, is superintendent, succeeding L. C. Henkel, resigned; R. L. Bowron, assistant general superintendent, Ensley works, has been made general superintendent; J. A. Lowman, general foreman, Ensley open hearth, has been made superintendent of Ensley open hearth.

Warner S. Hays has been appointed managing director of the American Welding Society, according to a recent announcement issued by A. E. Gibson, President of the Society. Mr. Hays brings to the Society an unusual combination of experience and background in engineering, sales, publishing, membership development and association management. He is a past president of the American Trade Association Executives, a member of the Philadelphia Rotary Club, the Yale Club of New York, and is on the executive committee of the Yale Engineering Association. He is also a former officer of the National Industrial Advertisers.

Mr. Hays was born in Cleveland, Ohio. Soon after his birth, the family moved to Scranton, Pennsylvania, where he attended public and high school. Mr. Hays was graduated from Yale Sheffield Scientific School, where he specialized in electrical engineering.

▲

E. H. Koenig, formerly chief engineer, Republic Steel Corp., Youngstown, O., has been appointed sales engineer with Freyn Engineering Co., Chicago. He previously had been identified with the latter company.

Died

Malcolm Montgomery Nesbit, Pittsburgh district representative, Automatic Transportation Company, died suddenly, in Louisville, Kentucky, April 23. Mr. Nesbit was graduated from Mercersburg Academy in 1915, and then entered Cornell University. He left college to enlist in the Naval Reserve,

MALCOMB MONTGOMERY NESBIT

before the United States entered the World War; he later enlisted in the Royal Flying Corps, with whom he served overseas and received the commission of first lieutenant. Upon his discharge, Mr. Nesbit returned to Pittsburgh, and established himself as representative to the steel industry for various commercial manufacturers.

Homer J. Forsythe general manager of the Hyatt Bearings Division, General Motors Corporation, Harrison, New Jersey, died after an emergency operation while on a visit to Pinehurst, North Carolina. Mr. Forsythe was in his 53rd year. He was born in Wilmington, Delaware, November 15th, 1883. His home was in Montclair, New Jersey.

From an executive position with the E. I. du Pont de Nemours Company in Wilmington, Mr. Forsythe came to Hyatt in 1921 as assistant general manager, and in 1922 was appointed general manager.

He was a director of the National Association of Manufacturers, and of the National State Bank of Newark.

▲

Arthur J. Skemp, superintendent of the hot sheet mills in the Gary sheet and tin mills of the Carnegie-Illinois Steel Corporation since 1932, died on Monday, April 5, as a result of a heart attack. He was fifty-three years old.

Mr. Skemp was born in Moxley, England on February 21, 1884. His father brought the family to Scottdale, Pennsylvania in 1891 and he was educated in the public schools there. He became associated with United States Steel Corporation subsidiaries at the age of sixteen in the Scottdale sheet mills of the former American Sheet and Tin Plate Company. Beginning at the bottom he advanced steadily, winning promotions until he became hot mill superintendent in Scottdale and finally manager in the two sheet mills in the Pennsylvania works. He left the manager's post to come to Gary in April, 1932. His father, Robert Skemp, was assistant to the late S. A. Davis, vice president of the American Sheet and Tin Plate Company.

ASSOCIATION ACTIVITIES

PITTSBURGH DISTRICT SECTION

Golf Party and Dinner

TUESDAY, MAY 25

Youghiogheny Country Club

McKEESPORT, PA.

Play may be started as early as 9:30 A.M., D. S. T. Foursomes will be listed as they report at first tee ready for play. The first score of the day will count in the distribution of the prizes. Dinner will be served from 6 to 8 P.M.

PHILADELPHIA DISTRICT SECTION

Inspection Trip

SUNDAY and MONDAY

MAY 23 - 24

Members, their wives and guests will have an opportunity to visit the plants of the Corning Glass Works, Monday morning from 9:30 to 12:30. This is the plant that cast the world's largest telescope lens. All those making the trip will furnish their own transportation. Headquarters will be at the Hotel Baron Steuben, Corning, N. Y. Those arriving early Sunday may play golf at the beautiful Corning Country Club. As guests of the Corning Glass Works there will be no green fees. Ladies are welcome.

Four High Finishing Train, (4 stands) Carnegie-Illinois Steel Corporation, New 100 Semi-continuous Plate Mill, Homestead, Pa.

Inspection Trip

JUNE 23, 1937 -- 1 P. M.

Members and guests of the Association will inspect the new 100" continuous plate mill of the Carnegie-Illinois Steel Corporation at Homestead, Pa., on June 23, 1937. Buses will leave the Grant Street entrance of the Wm. Penn Hotel at 1:00 P.M.

TECHNICAL SESSION JUNE 23

"FLOOD PROTECTION AND REHABILITATION SYMPOSIUM" at 8:00 P.M., preceded by an informal dinner at 6:30 P.M. Cardinal Room, Wm. Penn Hotel.

CHICAGO DISTRICT SECTION

Golf Tournament

TUESDAY, MAY 25

Coghill Golf and Country Club

119th AND ARCHER AVE.
LEMONT, ILL.

Only the afternoon scores will count in the distribution of the prizes. Bring a foursome with you or we will form one for you at the first tee.